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Power Generation

August, 1948

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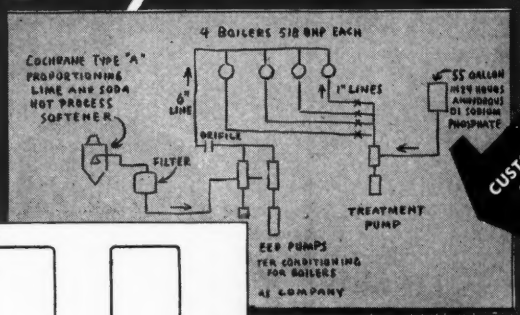
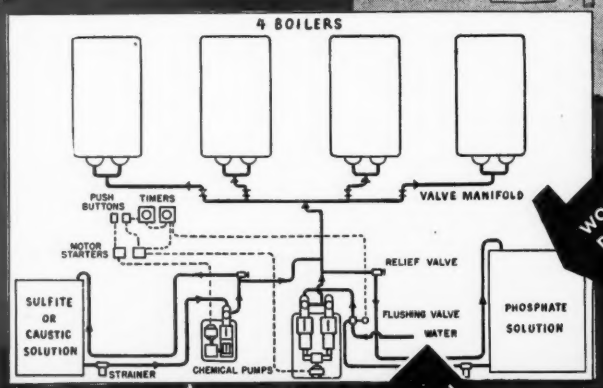
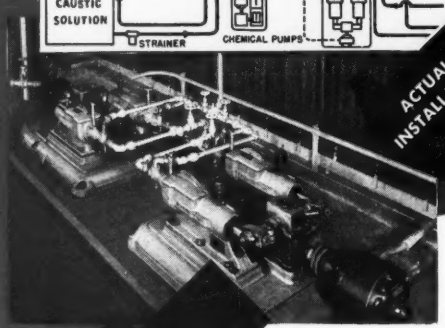
Adding the *proper* treating chemical, in the *correct* proportion, in the *right* location, at the *right* time.


4 BOILERS 518 BHP EACH
COCHRANE TYPE "A" PROPORTIONING LIME AND SODA HOT PROCESS SOFTENER
6" LINE
1" LINES
55 GALLON MIXING HOUSE AMMONIUM DI SODIUM PHOSPHATE
ORIFICE
FILTER
TREATMENT PUMP
FEED PUMPS FOR CONDITIONING FOR BOILERS AT COMPANY

CUSTOMER'S SKETCH



WORKING DIAGRAM



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The success of your chemical treatment depends on strict adherence to an operating program. In many cases insufficient importance is given to the *method* and *regularity* with which the treatment is injected. By using the tried and proven %Proportioneers% system, you eliminate guesswork, assure accurate treatment, safeguard your boiler investment, improve heat transmission, save fuel and reduce costly shutdowns for repairs and cleaning.

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ENGINEERS' PREVIEW

FIRST COMPLETELY synthetic varnish made from a new petroleum chemical, glycerol allyl ether, was recently revealed before the American Chemical Society by chemists from Shell Development Company. The new varnish forms insoluble films, hard to damage with chemicals and resistant to scratching. Manufacturers are expected to apply the new varnish where they now use resins made from a combination of synthetic materials and scarce natural drying oils. H. Dannenburg, T. F. Bradley and T. W. Evans were the Shell chemists who did the research.

★ ★ ★

ANOTHER FIRST in the gas turbine field—the world's first automobile gas turbine engine, announced to the public in May and displayed at the British Industry's Fair in Birmingham, England. While this may not seem so important to power engineers as the announcement of the first gas turbine to be installed solely for power generating purposes in a utility plant, reported on page 65 of the May 1948 issue of POWER GENERATION, still it may have, if it develops according to the optimists, far-reaching industrial and social consequences.

The new engine has been developed by the Power Jets Co. owned by the British Government. The engine is 5 ft long, weighs 1250 lb and was invented by R. H. Barr and Jeffrey White. This prototype engine develops 160 bhp. While the major fuel of the new engine is Diesel fuel, it will operate on other fuels and could, according to its sponsors, run even on "old candle ends." Any substance that gives a continuous flame could be used as fuel for this new engine, it is claimed. It is indicated that its commercial development may require some two or three years and it is obvious that the development will involve a very real change in automobile design and that considerable thought must be given to the effect of this on production.

★ ★ ★

DURING the past year or so, a proposed method for sampling of steam has been worked out by joint co-operation between ASTM Committee D-19 on Water for Industrial Uses and the Power Test Code Committee of the American Society of Mechanical Engineers through PTC Committee No. 19. This committee is co-ordinating ASTM and ASME views on this important subject. The proposed method is described in detail, with full specifications for the equipment required and methods for using it, in the March 1948 issue of ASTM Bulletin. That is a proposed method only and is published for further comment. It involves the use of a steam sampling nozzle, piping, necessary valves and fittings and, when required, a sample condenser and cooler. All engineers concerned with steam sampling and interested in the latest proposals on this subject should secure a copy of the above article from the American Society for Testing Materials, 1916 Race Street, Philadelphia, Pa.

PROGRESS in production of the anthratube, a new type of automatic anthracite heater, was recently reported before the Anthracite Conference at Lehigh University. The heater has been simplified in construction and made smaller, so that a unit capable of heating an 8-room house now measures 42 in. high, 23 in. wide and 31 in. long. Overall efficiency, it is claimed, is 80 per cent. Several hundred units of the anthratube have been installed in homes by three manufacturers since last October. Dr. Raymond C. Johnson of the Anthracite Institute reports that those installed in the field have been troublefree and have given satisfactory operation. There are now other manufacturers, he says, interested in building units based on the anthratube and centrifugal heat absorber principles, two new principles in the field. Within the last year the Motor Stoker Co. has introduced a new boiler burner unit employing induced draft and the centrifugal heat absorber principle. In another paper before the conference, a new extrusion process was reported by which dust-sized particles of anthracite, hitherto discarded, may now be combined with a binder and added to the nation's fuel stock pile. The material is made into pellets and appears to be suitable for use in commercial and industrial travelling grate stokers and small domestic equipment, where moderate burning rates and low banking rates are normal. Also reported were investigations on use of anthracite fines in coke production.

★ ★ ★

UP-TO-DATE LIST of all national standards approved by The American Standards Association has just been published and is now available free of charge from The American Standards Association, 70 East 45th St., New York 17, New York.

★ ★ ★

PRINCIPLE of the proximity fuse developed during the war has now been applied to the design of a rat trap, known as the radar rat trap. It is a completely automatic device, set in motion when the rat enters an electrically-charged field in the middle of the entrance tunnel of the trap. Absorption of the electrical charge by the rat's body at once shuts the doors of the trap. It is claimed that the rat is killed positively and without any burning or singeing, then his dead body is ejected from the trap and the doors to the entrance tunnel are again opened to await the next victim. The device is an invention of John C. O'Brien, a Rochester electrical engineer. Certainly if he has designed a practical and economical rat trap he will have performed a distinct service not only to the home but to industry. In some industries, such as those dealing with foods, grains, and textiles, the damage done by rats in a year is tremendous. In 20 years, it is claimed, rats have done enough damage in the United States to pay the entire cost of the Marshall Plan for rehabilitating Europe. Governmental departments variously estimate the annual loss caused by rats at from half to three-quarters of a billion dollars. Rats have never heard of birth control. According to the United States Public Health Service, a single pair of rats could product 940,369,969,-152 offspring in 5 years provided all their descendants were healthy and undisturbed. So if Mr. O'Brien can rout the rats with radar, he may have something.

TWO REVISIONS in the book Standard Practices for Stationary Diesel Engines have been announced by the Diesel Engine Manufacturers Association. Formal notice of these revisions is being given through a printed page, which may be inserted in the chapter titled Standard Performance and Equipment. One change is the addition of a new curve giving altitude ratings for turbocharged Diesel engines. Altitude above sea level is given in meters as well as feet, in order to make the curve adaptable to the new Spanish edition of Standard Practices. The second revision is the omission of the fuel tolerance of three per cent. Full data on these revisions may be obtained from Diesel Engine Manufacturers Association, 1 N. LaSalle Street, Chicago, Ill.

★ ★ ★

HEAT GENERATED in the mass concrete of large dams during setting is dissipated by artificial cooling throughout the mass, as first practiced in the construction of Hoover Dam and afterwards extended and improved upon at Grand Coulee and other large dams in the West. Readers of POWER GENERATION and its predecessor POWER PLANT ENGINEERING are, of course, familiar with this technique, for it was covered in detail some years ago in the descriptions of those dams in these pages. However, another refinement on this dam-cooling technique has recently been developed and used in the construction of the new Bull Shoals Dam on the White River in Arkansas by the Corps of Engineers, U.S. Army. Recent practice elsewhere has been to precool the concrete solely by the use of iced or chilled mixing water; but at Bull Shoals it was found this would mean addition of so much water to the concrete as to increase its proportions beyond the limits specified for the mix. Hence the cooling is supplemented by precooling the aggregates and the sand, as *Compressed Air* explains. Aggregates are chilled by immersing them for whatever length of time may be required in water at 35 F, circulated at 2000 gpm in large steel tanks. There is a restriction against wetting the sand before it enters the concrete mixers, however. So the sand will be cooled in devices based on the heat exchanger principle. Both the aggregate and sand coolers are housed in refrigerated buildings to which the material will be delivered by belt conveyors. In addition to the precooling provisions, the concrete will be cooled in the conventional manner by circulating 50 F water through grids of 1-in. piping both during and after placing. At certain times, the river water will drop to 50 F and will be used for cooling and then wasted. At all other times refrigerated water will be circulated in a closed system. A refrigeration plant of 1640 tons capacity will be provided.

★ ★ ★

WARTIME INVESTIGATION of the meta-anthracite deposits in Newport and Providence Counties, Rhode Island, undertaken to help relieve fuel shortages in the New England states, is described in a report released recently by the Bureau of Mines. A hard coal, usually resembling graphite and lacking the free-burning characteristics of ordinary anthracite and bituminous coals, meta-anthracite is found exclusively in Rhode Island. The above publication gives detailed information on the field, physical and chemical characteristics of the deposits and other data. It is Report of Investigations, 4276 and may be obtained from the Publications Section of the Bureau of Mines, 4800 Forbes St., Pittsburgh 13, Pa.

UNIVAC, a machine developed by the Bureau of Standards, will be designed to compute the chances of success of a new business in a given community. It is a high speed electronic computer and is to be installed at the Bureau of the Census. Here is how it will work: Suppose you want to find out if you can sell fur-lined prenulating fromttons in West Mustache, Wissafornia. You want to know if a $150,000 retailing and servicing house for these fromttons would go boom or bust. According to *Business Week*, the Univac would get you the answer something like this:

(1) Census first collects all the information it has on West Mustache from population, business and other Census files.

(2) It feeds this information, already on punch cards, into a unit that transfers it all to a magnetic tape.

(3) Census then takes another tape, already prepared, which carries full instructions for Univac covering problems of starting new retail businesses.

(4) A third tape is prepared with all information needed in the particular case of the fromttons; such as that the plant will cost $150,000, will handle only the automatic brand—any information that the business man must supply.

Finally, all this information is fed into the Univac which checks it all over against the instruction tape and might come out with an answer such as: "No, already there are 35 such establishments in West Mustache; it won't work" or, "You're rich, open up quick. The high altitude, cold nights and excess of female over male population should create a heavy demand for your fromttons!"

As in all these new automatic devices, nothing is said about the incorporation of the Oxometer.

★ ★ ★

THOSE INTERESTED in various developments in use of oxygen in industry and speculating on its various applications in the power plant and other fields, will note the announcement of the successful development of a new process for manufacture of tonnage oxygen by Elliott Co. The Elliott process is claimed to be a completely new system and to differ in principle from systems developed abroad and now used in this country.

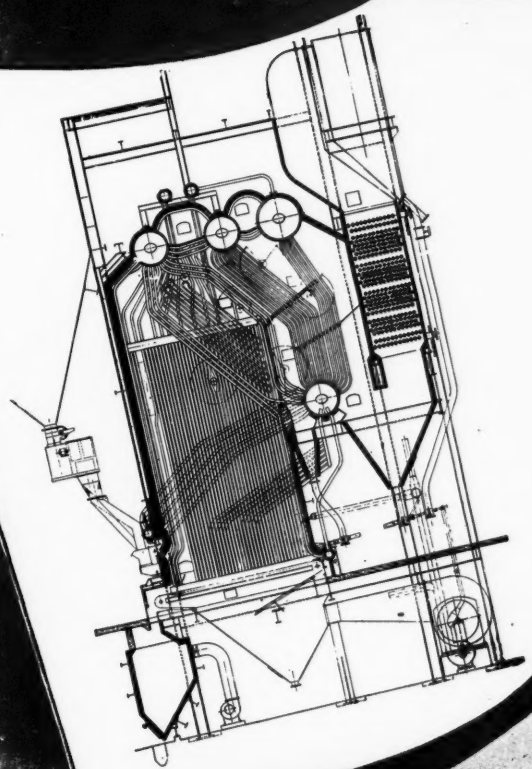
According to Elliott, the outstanding features of this process are as follows: (1) The plant is not subjected to the necessity for periodic shutdowns to remove accumulated deposits of water and carbon dioxide; (2) The system is completely immune to the possible dangers of acetylene explosion; (3) the process operates at low loads without sacrificing efficiency; (4) The system is mechanically simplified; (5) All contrils are automatic; (6) Recovery of oxygens from the air is more than 97 per cent; (7) Oxygen as pure as 99.5 per cent can be made by the process.

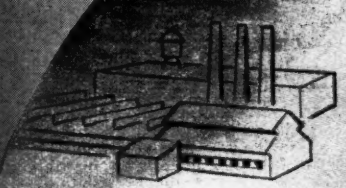
★ ★ ★

PERMENORM 5000-Z, a new magnetic alloy, which will make possible revolutionary changes in the rectification of electrical power, has been reproduced in the United States for the first time by scientists at the Naval Ordnance Laboratory. The alloy was first synthesized in Germany, samples of it were found by allied technical missions after the war, but although the details of the process were available, the metal could not be successfully duplicated because of the intricate heat treating process required. The NOL scientists have now duplicated the German process and, in addition, developed a more satisfactory process that will adapt the material to modern mass production techniques.

WICKES HELPS MAINTAIN

high quality of paper board





This Wickes 4-Drum Boiler contributes its high efficiency to the manufacture of quality paper board at the River Raisin Paper Co., Monroe, Michigan. It is a unit in the power generating system designed and coordinated by Cummins & Barnard, Inc., Consulting Engineers, Ann Arbor, Michigan. Specifications include 180,000 lb. steam per hour capacity, design pressure 700 psi, and total temperature 750° F. We build and design boilers of all types up to 250,000 lb. steam per hour and 850 psi, and are always glad to cooperate with engineers in the development of equipment for specific projects.

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THE WICKES BOILER CO.

DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

RECOGNIZED QUALITY SINCE 1854

Can you hang this sign on your turbines?

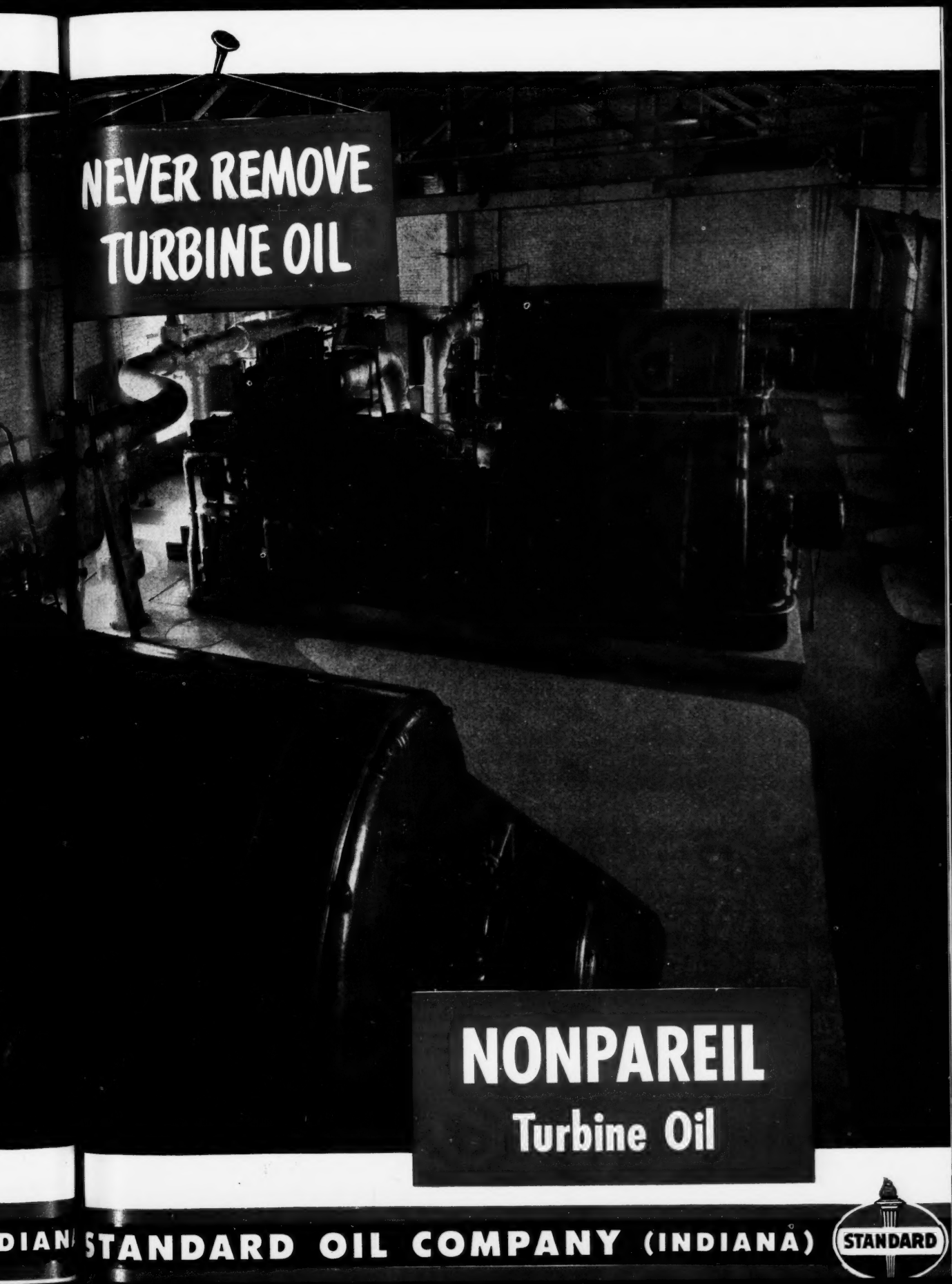
Could the oil in your turbines today be left there for the next 10 or 15 or 20 years without removal for treating, resting, or cleaning the oil system? Yes, if it were Nonpareil Turbine Oil. For instance, take Nonpareil's operating record in the midwest utility plant shown at right.

Nonpareil was put into three 5,000 KW General Electric turbines in July 1932, November 1934, and November 1940, respectively. The first fills of Nonpareil have never been removed from the three turbines. In 16 years' operation in one unit, Nonpareil maintained an average neutralization number of .06 mg. KOH/gm. Because of low-acidity operation, there has been no need for treating oil or cleaning turbine oil systems.

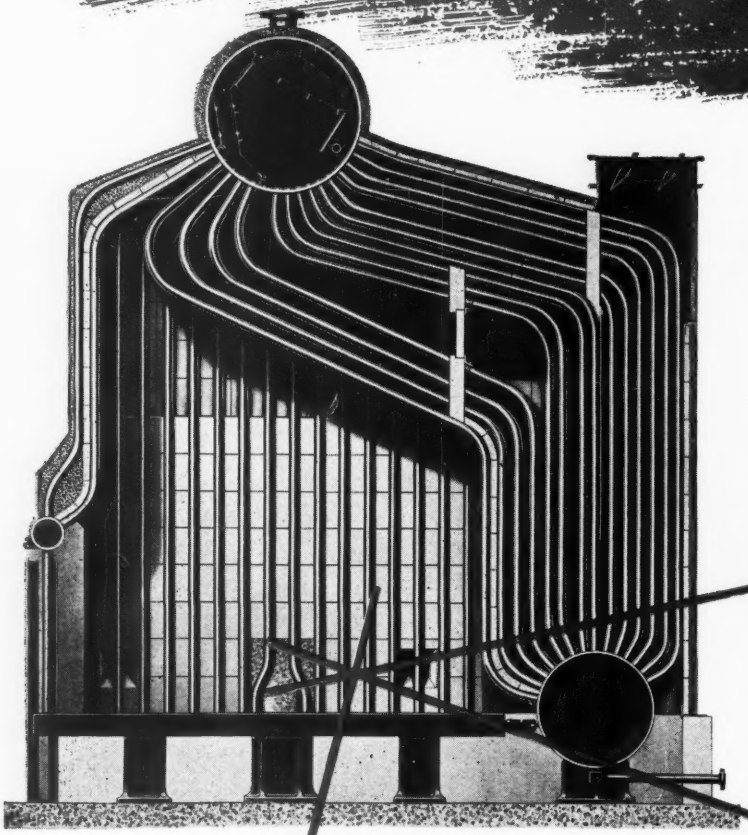
Why risk dangerous acidity increase that can lead to the formation of harmful deposits and emulsions in turbine oil? Make your next fill Nonpareil Turbine Oil. It contains anti-corrosion and anti-foaming agents further to assure safe operation for the "life of your turbine."

Ask a Standard Oil Lubrication Engineer about the benefits of the written guarantee you receive with Nonpareil. Write Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.

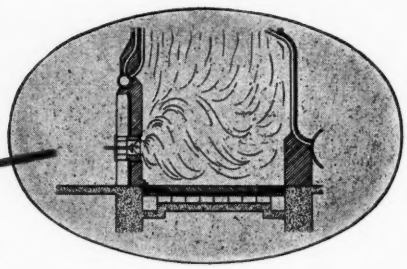
STANDARD OIL COMPANY (INDIANA)


NEVER REMOVE
TURBINE OIL
NONPAREIL
Turbine Oil
STANDARD OIL COMPANY (INDIANA)
STANDARD

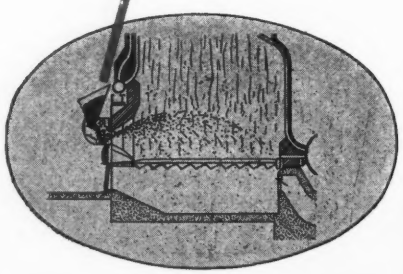
THE C-E PACKAGE BOILER



Furnished in capacities of
15,000 to 50,000
lb of steam per hr, the Package Boiler is designed for four methods of firing — spreader stoker, single-retort underfeed stoker, oil or gas burners. Any of these methods may be substituted for any other should a change in the fuel market make a change in firing equipment desirable.



OIL OR GAS BURNERS — The Package Boiler is ideally suited to the use of either oil or gas. Designed for front wall firing, the furnace is properly proportioned for the normal flame characteristics of the burners and provides ample volume for completion of combustion before the gases enter the boiler.



C-E SPREADER STOKER — Installations of C-E Spreader Stokers throughout the United States and in many foreign countries have demonstrated the ability of this stoker to burn every kind and grade of bituminous coal, as well as sub-bituminous coals and lignite. It has been notably successful in burning the lower-priced poorer grades of coal which are so difficult to burn satisfactorily on other types of stokers.

COMBUSTION

C-E PRODUCTS INCLUDE ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

Choice of industry after industry

Why has the Package Boiler been selected by such widely varying industries as those listed?

BALANCED DESIGN

BECAUSE it has not one or two features for special needs, but a *completely balanced design* that adapts itself to many conditions . . . a design in which each element is coordinated with every other for top performance.

EFFICIENT PERFORMANCE

BECAUSE the C-E Package Boiler has high efficiency over a wide range of output and responds to rapid load swings . . . characteristics especially advantageous in many industrial plants.

EASY OPERATION

BECAUSE the C-E Package Boiler is simple to operate and maintain at peak efficiency — a boon to plants having limited personnel.

CHOICE OF FUELS AND FIRING

BECAUSE in addition to its wide adaptability, the C-E Package Boiler permits you to choose the one *best* method of firing for the fuel and load conditions of *your* plant.

LOWER COST

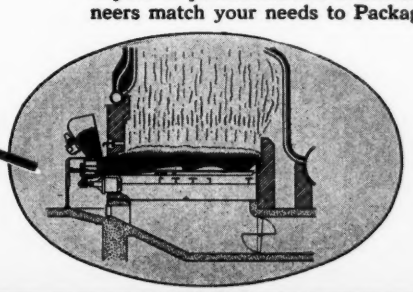
BECAUSE the standardized balanced design of the C-E Package Boiler effects economies in engineering, fabrication, and erection which are passed on to you in lower first cost.

UNIFIED RESPONSIBILITY

BECAUSE the C-E Package Boiler is a complete unit . . . boiler, furnace setting, fuel-burning equipment, controls, forced draft . . . giving you the added benefit of *one contract, one guarantee* and *one responsibility.*

• • •

Small wonder so many diverse industries select the C-E Package Boiler. If your requirements fall within the available capacity range, let C-E engineers match your needs to Package Boiler performance. B-231



TYPE E UNDERFEED STOKER — Designed to burn both caking and non-caking bituminous coals, the Type E Stoker is one of the oldest and best-known stokers in America. Sound design, rugged construction and fine performance have made the Type E Stoker the recognized leader in its field.

PARTIAL LIST OF INDUSTRIES THAT HAVE SELECTED THE C-E PACKAGE BOILER

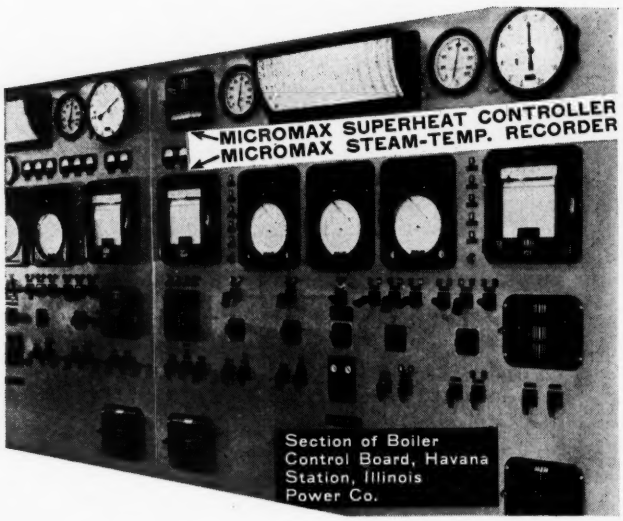
AUTOMOBILE
BAKERY
CHEMICAL
COLD STORAGE
DAIRY
GLASS
HOSIERY
HOSPITAL
INSTITUTIONS
LEATHER
LINOLEUM
MACHINERY
METALS
OIL
PACKING
PAINTS
PAPER
RAILROADS
RUBBER
STEEL
SUGAR
TEXTILE
TOBACCO
UTILITY

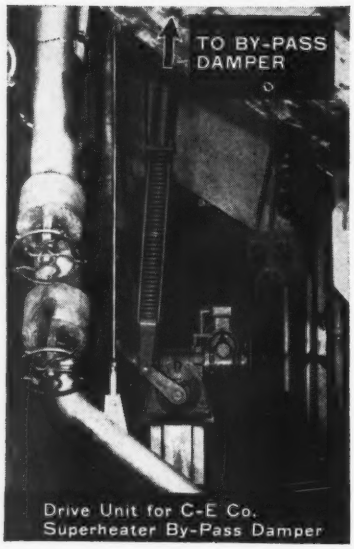
COMBUSTION ENGINEERING

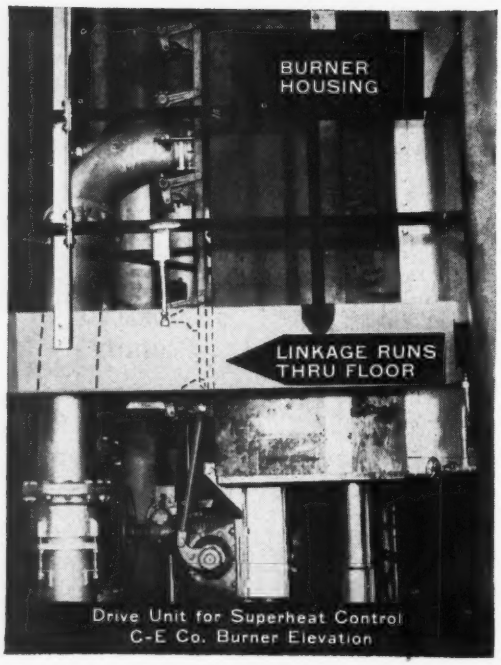
200 MADISON AVENUE, NEW YORK 16, N. Y.

Superheat Control?

Investigate MICROMAX With Its Fast, Positive Electric Drive Units


MICROMAX SUPERHEAT CONTROLLER
MICROMAX STEAM-TEMP. RECORDER
Section of Boiler Control Board, Havana Station, Illinois Power Co.





THE precise, dependable action of Micromax Superheat Control is well illustrated in its application to Combustion Engineering Co.'s regulating mechanism.

C-E's method of varying the number of Btu's to the superheater involves both tilting the four fuel burners up or down, and moving the superheater's by-pass damper.

Micromax Control System regulates burners and damper through five powerful, electric Drive Units. Four Units move the burners. They operate in unison, to the same tilt angle, because all respond to a single Micromax Controller. The fifth Drive Unit operates the by-pass damper, in automatic coordination with the burner-tilts.

Micromax System readily accommodates itself to details of installation which vary with the boiler. Always, the Superheat Control is sensitive, accurate and dependable.

Other advantages of the Micromax system apply to any type of superheat control:

1) Heaviest dampers, louvres, vanes, etc., move quickly to exact position, because the Units' reduction gears apply high torque with high precision.

2) Dampers, etc., stay in position even in event of power failure, because back-drive through the gear train is impossible.

3) Operator can then easily position dampers manually with a handwheel, if ever desired.

4) Continuity of service is high, because equipment uses dependable electric power.

5) Inherent lag between change in boiler load and change in steam temperature is minimized.

For further information, write Leeds & Northrup Co., 4973 Stenton Avenue, Philadelphia 44, Pa.

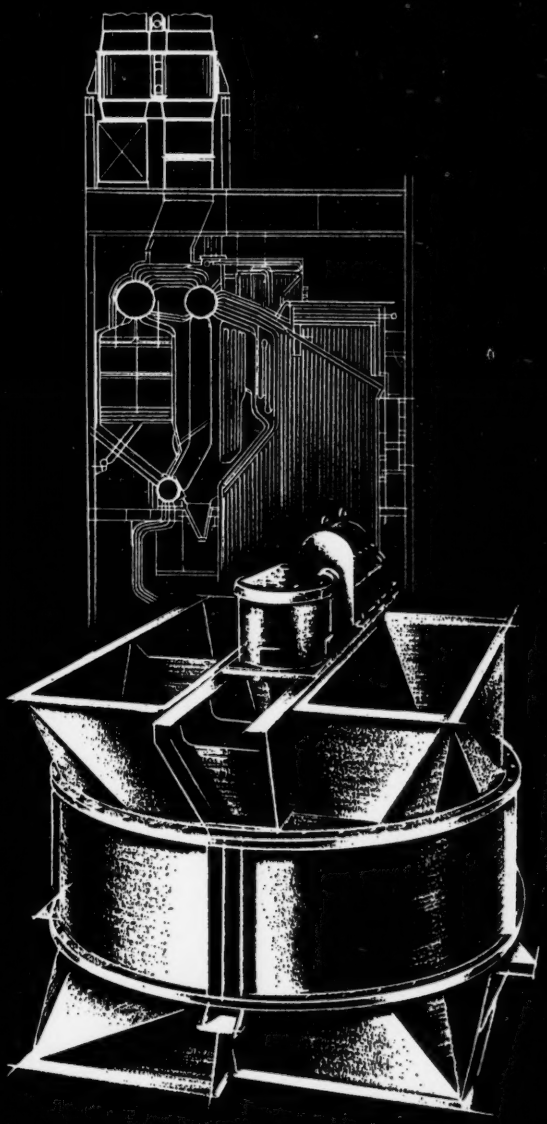
LEEDS & NORTHRUP

MEASURING INSTRUMENTS · AUTOMATIC CONTROLS · TELEMETERS
HEAT-TREATING FURNACES

Jrl. Ad N-01-463(1)

Designed for Preheat

when heat recovery must be pushed to the limit



With the Ljungstrom Air Preheater, it is practical to reach low exit-gas temperatures.

While plans for steam generation plants are under consideration, investigate the possibilities of the Ljungstrom. The specialized experience of Air Preheater engineers is at your disposal, to aid in effecting the most economic heat recovery from flue gases.

The Air Preheater Corporation

EXECUTIVE OFFICES: 60 East 42nd Street, New York 17, N. Y. • PLANT: Wellsville, N. Y.

REPUBLIC VALVES REPUBLIC

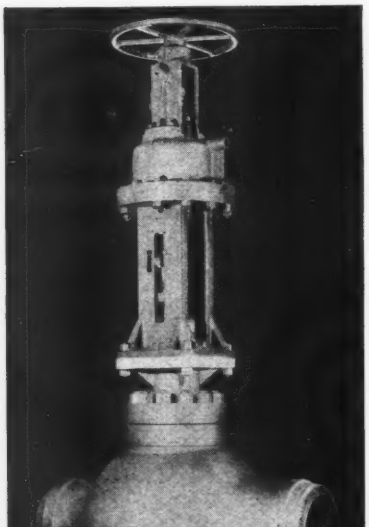
REGULATING—PRESSURE REDUCING—SHUTOFF

CYLINDER OPERATED

Republic cylinder operated valves are of the gradual opening, high lift, double seated type. They are hydraulicly operated to assure smooth performance at any speed regardless of size, static pressure or pressure reduction. These valves are available in sizes from 3" to 24", with or without hand operating wheel. Due to compact design, a regulator may be mounted directly on the valve.

HAND OPERATED

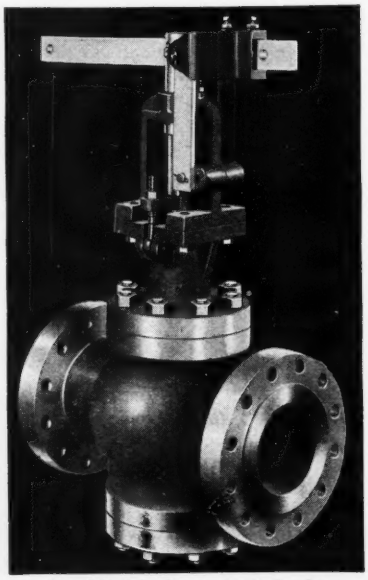
Republic hand operated valves, in sizes from 1" to 8", are built to 900 lb. and 1500 lb. pressure standards. Sizes up to 2" are also available for 600 lb. pressure. They are of the single seated type, have a one piece valve stem, and seat rings that are Stellite surfaced. On the larger sizes the gear reduction head is built with ball or roller bearings and precision ground gears for minimum friction and back lash.



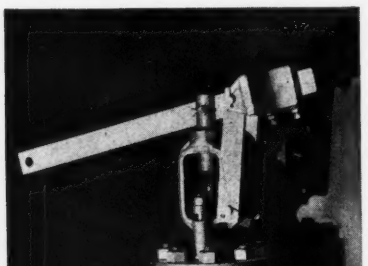
Republic 12 in. cylinder operated valve

For your key jobs, where valves must not fail—where they must continuously and accurately regulate the pressures and flows of steam and water on which other vital processes depend—Republic valves give you the dependability you need.

Let a Republic Engineer consult with you on your specific pressure and flow regulating problems.



Republic 6 in. lever operated valve



Republic 2 in. lever operated valve

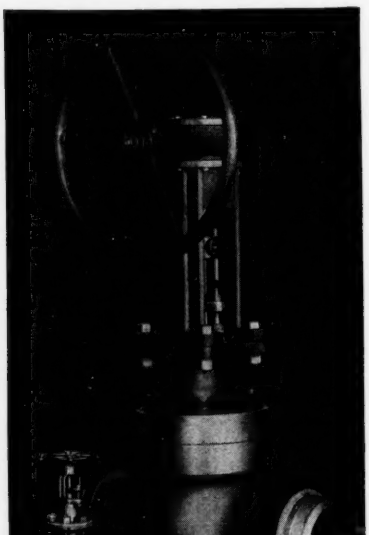
LEVER OPERATED

Republic double seated lever operated valves are available in sizes from 3" to 16" for low pressure applications and in sizes up to 6" for 1500 lb. applications. They are ideal for air actuation with long stroke cylinders. The lever mechanism is of sturdy construction capable of taking full strain of power cylinder.

Single seated lever operated valves are available in sizes up to 2" and for pressure up to 1500 lb. standard. The sturdy lever mechanism is adjustable for lift.

BUTTERFLY VALVES

Republic butterfly valves can be supplied in cast iron or steel for pressures up to 300 lbs. Vanes can be supplied of the angle seating or swing through types. The shaft can be mounted on ball or plain bearings as required. A valve operator may be mounted directly on valves of 6" size and over.



Republic 6 in. hand operated valve

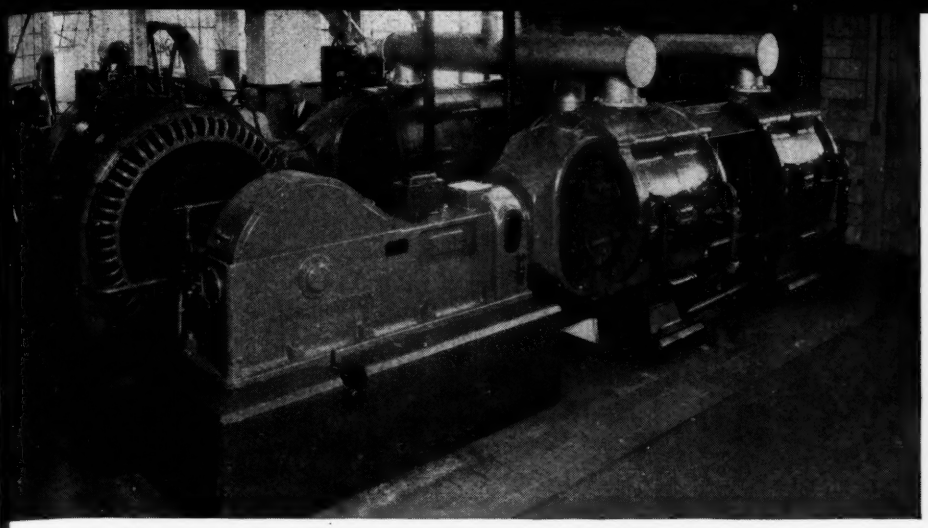
REPUBLIC FLOW METERS CO.

2240 Diversey Parkway, Chicago 47, Illinois

NEWS

FROM THE POWER FRONT

AS REPORTED BY THE DEVELOPMENT ENGINEERS FIELD SERVICE REPRESENTATIVES AND CUSTOMERS OF WORTHINGTON



Worthington 32 x 16 Twin Tandem Vacuum Pump at Buffalo Electrochemical Co. Inc.

Triples the Run

Hydrogen Peroxide is manufactured by Buffalo Electrochemical Co. Inc.

Originally, vacuum pumps of the slide-valve type were used, and these were imported from Switzerland because no other pumps were available in this country that could meet specifications at a reasonable price. During the war—at the very time production requirements expanded—the Swiss pumps were unavailable. So BECCO engineers made a thorough study of all domestic pumps to determine which make would handle the highly oxidizing and corrosive gases with the least possibility of failure.

The result of the investigation was the selection of a Worthington 32 x 16 twin-tandem, two-stage, four-cylinder dry vacuum pump. The reason for the selection was chiefly the simplicity of the Worthington Feather* Valve, the lightest, tightest, quietest ever made.

Although the installation was considered experimental, inspection following the initial 10-week run showed that its performance exceeded that of the original Swiss pumps. Since then, the Worthington pump has operated on regular 10-week periods between inspections and cleaning, as compared with previous 3-week periods.

The pump is rated at 5571 cfm displacement—approximately 20% larger than other existing pumps—and is suitable for handling vacuum down to 0.25 in. Hg absolute. The guaranteed vacuum on blank suction of 0.25 in. has been exceeded.

Reg. U.S. Pat. Off.

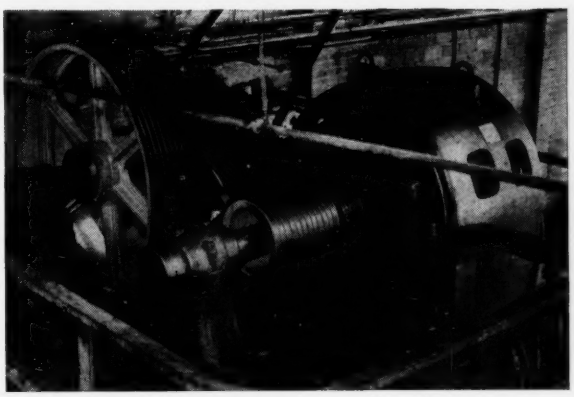
All Quiet on the Clay Machine

A chain drive to a 150 hp clay machine in an Akron, Ohio, plant had been annoying workers with its noise and keeping maintenance men busy with repairs. Each case of break-down involved work interruption for at least a dozen men.

To replace the chain drive, a Worthington Multi-V-Drive was installed—14.5 in. QD driver sheave and 58.0 in. QD driven sheave, with 12 Worthington-Goodyear Steel Cable V-Belts, "D" Section.

This unit is driving a line shaft transmitting 150 hp from flat belting to two pug mills which operate one at a time. The drive is designed to meet this change-over in operation. The drive motor is rated at 300 hp.

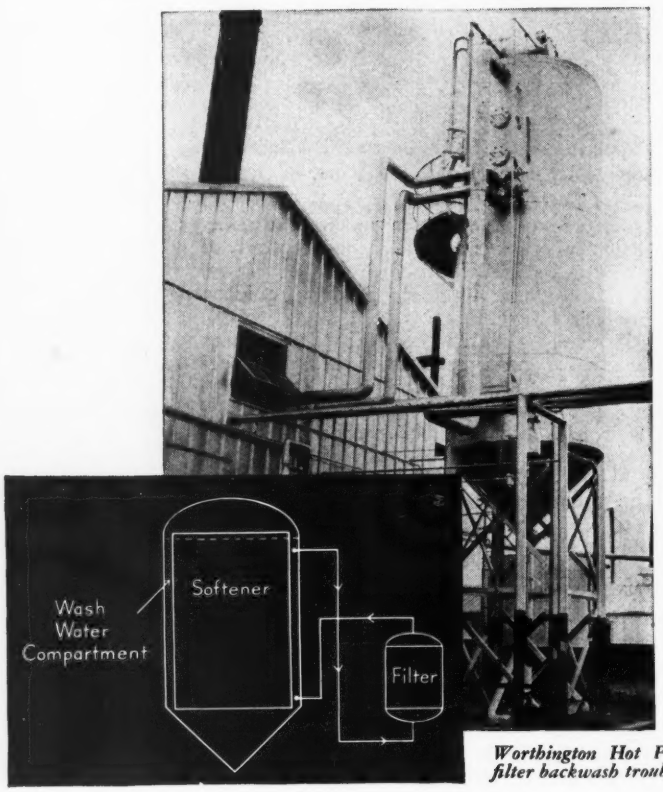
The job was installed and operating seven and one-half hours after arrival at the plant.



Worthington—Goodyear Multi-V-Drive on clay machine (pug Mill) in Akron plant.

NEWS from the power front

The Only Uniformly Continuous Hot Process Water Softener



Worthington Hot Process Deaerating Softener design eliminates filter backwash troubles.

Continuously uniform water treating results can be obtained only if treating process remains undisturbed during recirculation of filter backwash water.

Worthington's exclusive design completely divorces the filter backwashing operation from the treating process, thereby permitting continuously uniform treatment and preventing filter deterioration.

A wash water storage and settling compartment (see diagram) provides clear, hot, deposit-free water for backwashing purposes, thereby eliminating filter difficulties, increasing the period between backwashing operations and decreasing the time of the backwashing operation. The filter is washed clean with clean water without disturbing the softening process.

10 Years in a Hospital and Never a Patient

Ten years ago, the Oak Forest Infirmary in Oak Forest, Illinois, installed a Worthington 600 kw geared direct-current turbine-generating unit.

Over the ten years, the unit has operated continuously and without attention in the way of service except for an inspection every four or five years.

The machine is a non-condensing unit operating on steam at 150 lb initial pressure, 0 deg F superheat, and exhausting to 3 lb back pressure. The exhaust is used for heating water, cooling, baking and to heat various buildings in the institution. No live steam direct from the boilers is used for heating since, in addition to the turbine-generating unit, most of the auxiliaries such as pumps and fans are steam-driven.

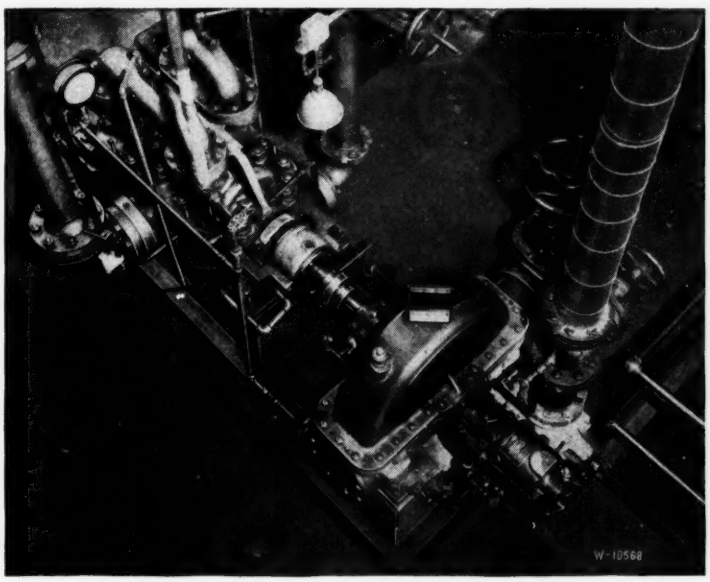
Worthington Turbine-Generator—Oak Forest Infirmary, Oak Forest, Ill.

It is estimated that the savings made by running their own plant, over the cost of purchased power and generating steam for heating only, have been substantial, paying for the Worthington unit a number of times over.

Worthington Pump and Machinery Corporation
Harrison, N. J.

NEWS

Pumping for Pipe Testing



Worthington 4-UX-1 Pump and Worthington T2RA Turbine . . . supplying high pressure water, A. M. Byers Company, Pittsburgh, Penna.

A. M. Byers Company, as you probably know, manufactures wrought iron pipe for many purposes—particularly for the fast-becoming-popular radiant type of heating.

All its pipe is carefully tested in the plant, and for this purpose it uses a weighted accumulator system. To supply the high pressure water, Byers selected a Worthington pump and Worthington turbine. Choice of the Worthington equipment was based primarily on its compactness, economy in steam consumption, and the speed with which it gets into operation.

The pump is a 4-UX-1, designed for capacities between 350 gpm and 500 gpm, producing 800 lb TDH with 50 ft or more of suction pressure. It runs at 3600 rpm, and the minimum BHP required at the maximum condition is 334.

The turbine is rated 350 hp at 3600 rpm, and operates on 156 lb steam with 50F superheat and 2 lb gauge back pressure. It is equipped with a hand speed changer.

Sewage Gas Engine Returns $199,000

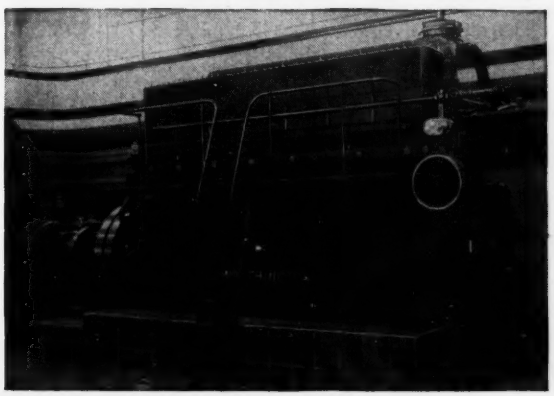
The annual report of the Fort Wayne (Indiana) sewage treatment plant reveals a 1946 saving of $38,000 by the 465 hp Worthington gas engine installation. This brings the total six-year saving to $199,000.

This plant, considered one of the outstanding municipal developments in the country and a focal point for inspection tours by engineers from other communities, was completed in 1940. Fort Wayne had been mandated by the Indiana State Board of Health to cease pollution of the Maumee River, and now the treated sewage is so free of offensive material that the river is capable of sustaining fish life.

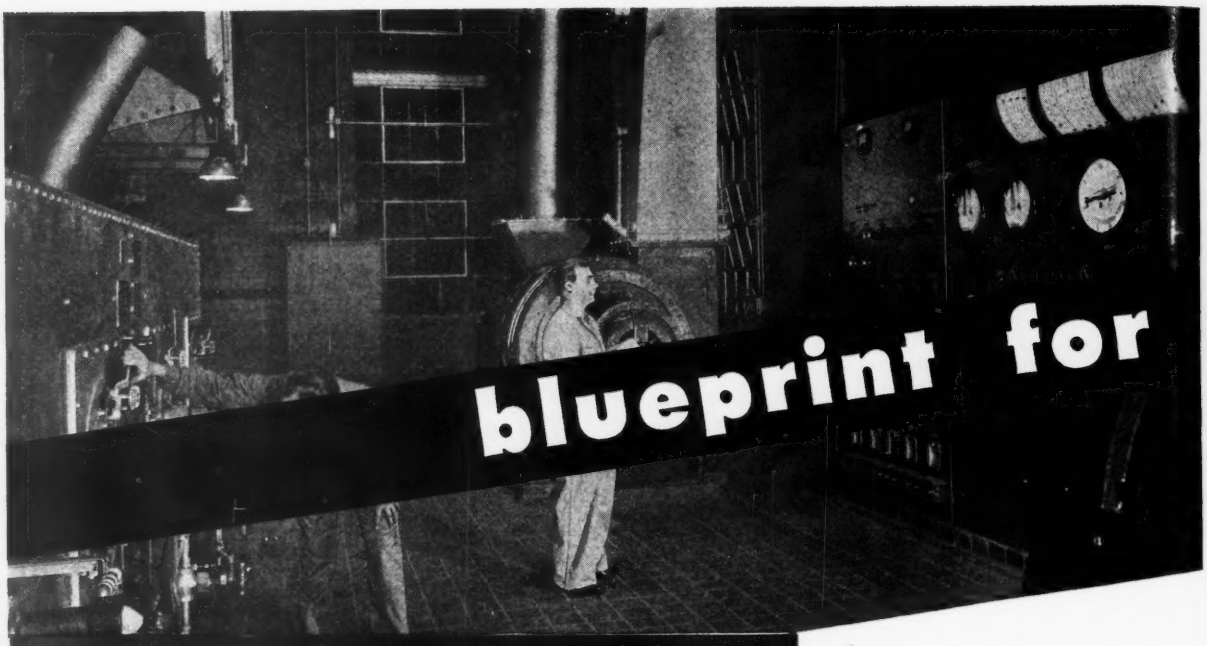
Total sewage treated in 1946 amounted to 6,648,960,000 gallons—an average of 18.73 million a day. From this 7,000 tons of sludge was removed, and into it 5,345,890,000 cubic feet of air was pumped.

The Worthington gas engine was originally purchased at a cost of $30,000. The estimated saving is based on what it would have cost otherwise for additional electric power.

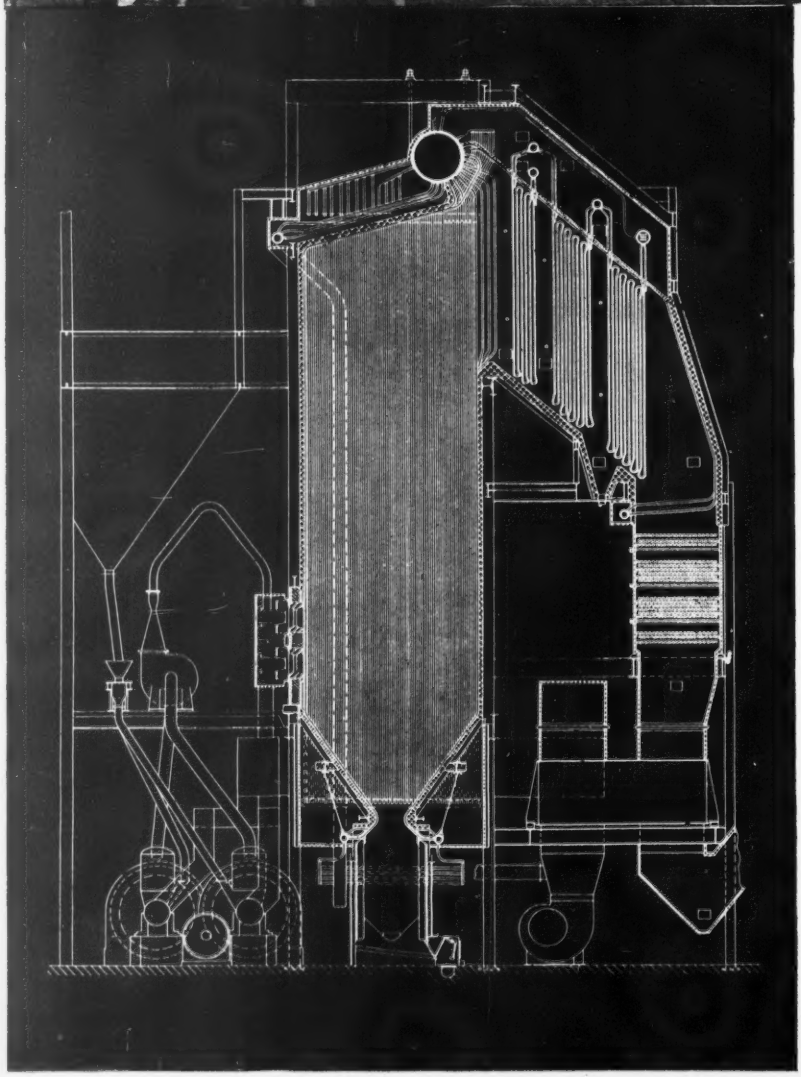
The engine contributes to heating the sludge digesters. The sludge is pumped in liquid form into four covered digesters where it is decomposed by bacteriological action, producing methane gas. Heat from the circulating water in the engine is used to raise the temperature of the sludge to the desired point for proper bacteriological digestion. In 1946, nine billion BTU's of heat went from the engine to the digesters—equivalent to 650 tons of coal.



Worthington Sewage Gas Engine—Fort Wayne, Indiana, Sewage Treatment Plant.



blueprint for



E. M. POSTON STATION
COLUMBUS AND SOUTHERN OHIO ELECTRIC COMPANY

Steam Capacity
425,000 lb per hr

Superheat control range
300,000 to 425,000 lb per hr

Pressure superheater outlet
1354 psi

Final steam temperature
955 F

Bituminous Coal Pulverized
in FW Ball Mills

Standardized Steam Generating Equipment for Central Stations

Foster Wheeler has demonstrated outstanding leadership in developing central station equipment which helped the Utility Industry to achieve increased productivity. A large share of the credit can be directly ascribed to the FW line of single-pass, baffle-less steam generators having liberal furnace dimensions. This arrangement has been used as the basis for "Preferred Standard" steam generator designs which have been developed by Foster Wheeler Corporation for the Utility Industry.

Engineering and Manufacturing Costs Reduced

The "Preferred Standard" steam generator design (suggested on the right) promises substantial savings by the reduction of engineering and fabrication costs.

Fixed Individual Equipment Details

The unit being built for the E. M. Poston Station of the Columbus and Southern Ohio Electric Company is typical of the single-pass design which Foster Wheeler is using as the basis for "Preferred Standard" steam generators. This standardized steam generator pattern with fixed individual equipment details may be readily applied to a series of single or twin furnace units varying in capacity from 300,000 lb per hr to over 1,000,000 lb per hr.

Other Foster Wheeler Fuel and Labor Saving Features

The design also embodies Foster Wheeler features of slag-free furnace arrangement, Foster Wheeler condenser-type steam temperature control, minimum baffles, low draft loss, and efficient heat recovery arrangement. When additional furnace cooling is required, the "Preferred Standard" design may readily incorporate a water cooled division wall.

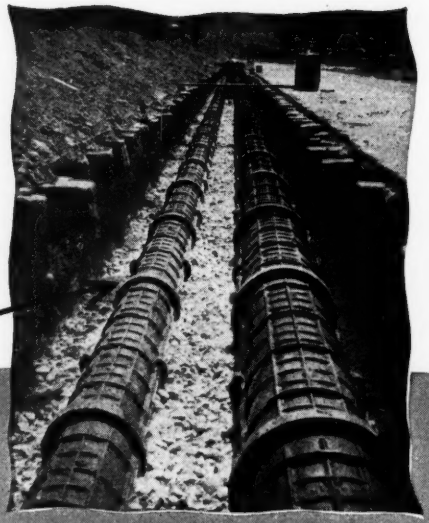
For additional information, write . . .

FOSTER WHEELER CORPORATION
165 BROADWAY, NEW YORK 6, N. Y.

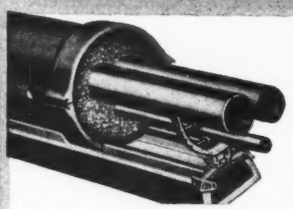
FOSTER WHEELER

RIC-WIL Tile and Cast Iron CONDUIT SYSTEMS

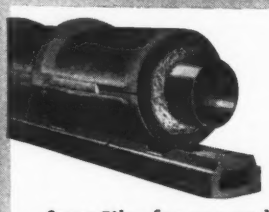
for underground insulated piping



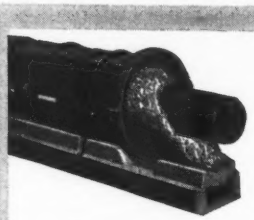
geared to the ground load



Standard Tile—for all normal ground load conditions.



Super Tile—for use under highways and heavy traffic.



Cast Iron—for use under or near railroad tracks.

Ric-wiL Standard Tile, Super Tile and Cast Iron Conduit Systems for steam, hot water, and oil distribution are designed so that all three types are interchangeable —an exclusive feature that permits any combination required to meet varied ground load conditions.

These Ric-wiL Systems meet every requirement for maximum protection and efficient insulation of underground pipe lines. Ric-wiL interlocking design and construction assure high strength, permanent alignment and extraordinary tightness in a thermally efficient conduit which can be quickly and economically installed.

- Non-settling base drain provides drainage in addition to supporting conduit and pipes.
- Correctly-engineered roller-type pipe supports carry the weight of the piping on the base drain.
- Tile conduit is scored for easy splitting and re-sealing after pipe and insulation are installed.
- Various types of insulation available for hand packing around pipes in conduit.

RIC-WIL

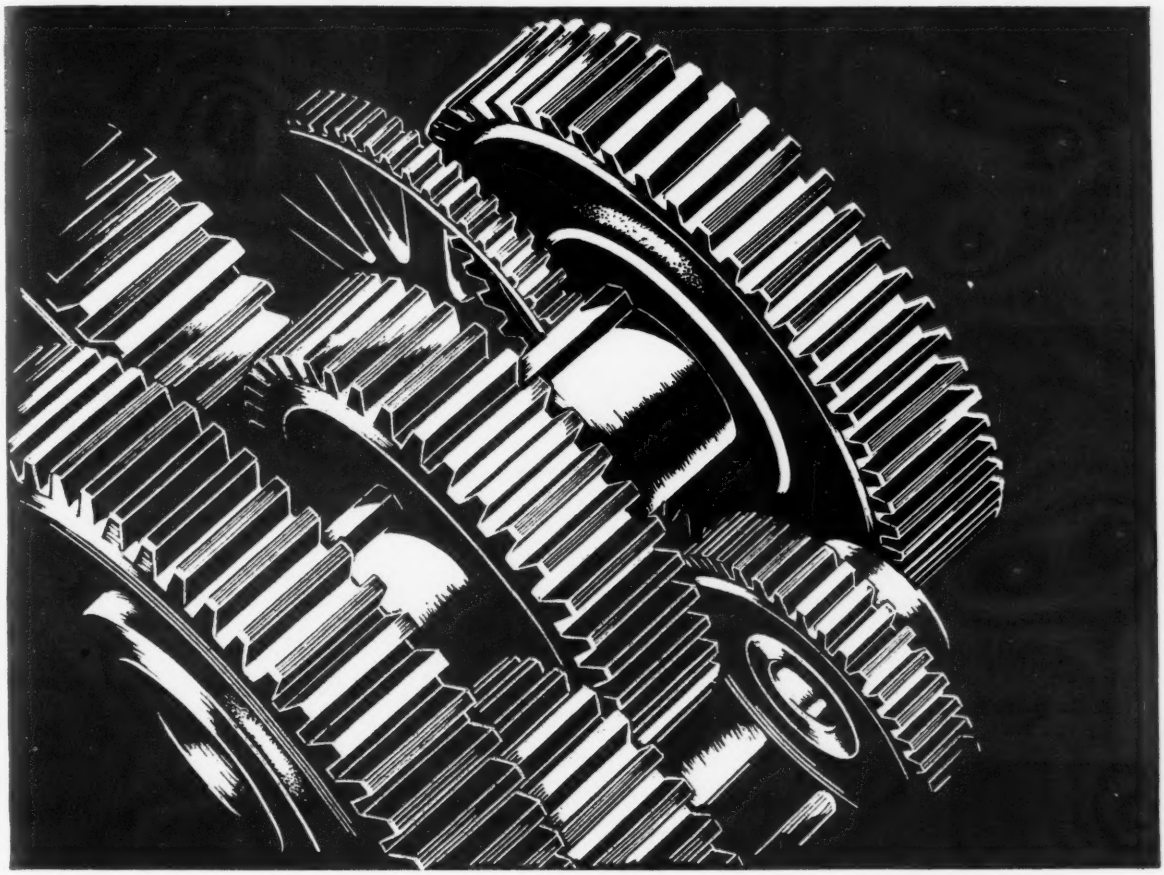
INSULATED PIPE CONDUIT SYSTEMS

THE RIC-WIL COMPANY • CLEVELAND, OHIO

CABLE ADDRESS: RICWIL, BENTLEY'S CODE

For full information and specifications, Form 4704, write The Ric-wiL Co., Cleveland, Ohio, Dept. 788

YES! Tycol "Engineered Lubrication" performs better . . . BETTER . . . BETTER



Tycol Engineered Lubrication performs better because:

. . . *Tycol Engineered Lubrication* supplies the scientific answer to every lubricating need in industry—from spindle oils for textile plants to roll neck greases for steel mills.

. . . *Tycol Engineered Lubrication* boosts production by promoting efficient, smoother-running machine operation . . . there's a Tycol oil or grease "engineered" for your specific job.

. . . *Tycol Engineered Lubrication* slashes costs by prolonging equipment life, protecting it against wear and tear . . . repair bills and "down time" are invariably reduced.

Let Tide Water Associated help you select the best lubricant for your particular need. Write, wire or phone today to your nearest Tide Water Associated Office for full details.

LUBRICATION—"ENGINEERED TO FIT THE JOB"

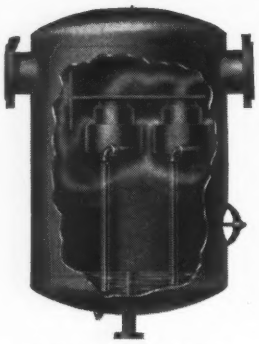
TYCOL

INDUSTRIAL LUBRICANTS

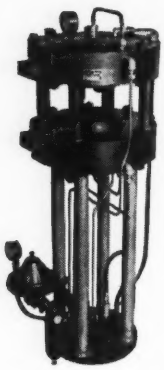
Boston • Charlotte, N. C.
Pittsburgh • Philadelphia
Chicago • Detroit • Tulsa
Cleveland • San Francisco

TIDE WATER ASSOCIATED OIL COMPANY

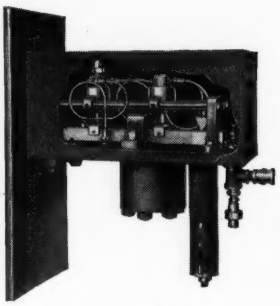
17 BATTERY PLACE - NEW YORK 4, N.Y.



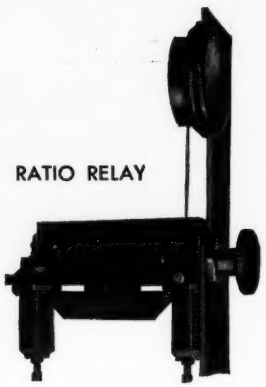
STEAM SEPARATOR



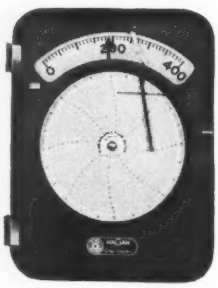
HAGAN THRUSTORQ



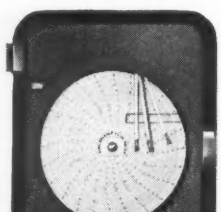
TYPE "F"
MASTER SENDER



RATIO RELAY



RING BALANCE
FLOW METER
(Indicating, Integrating
& Recording)



RING BALANCE
FLOW METER
(Integrating & Recording)

Typical applications for

This partial list, and accompanying photographs are published to remind you that Hagan service is broader than the automatic combustion control systems which are usually associated with the Hagan name.

Control of combustion rate of boilers

Constant or graduated draft control

Constant or graduated pressure control

Feeder or stoker speed control

Control of multiple fuel firing

Fan speed control

Pump speed control

Hydraulic coupling control from speed or delivery of driven unit

Constant differential pressure control (liquids or gases)

Accurate control of position from remote point

Control of steam, gas, and liquid pressures

Measurement of steam, gas and liquid pressures

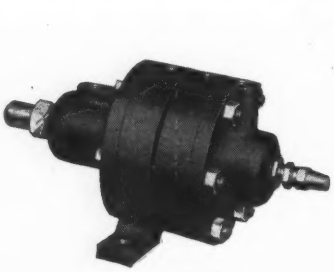
Control of pump discharge pressure and flow

Steam flow control

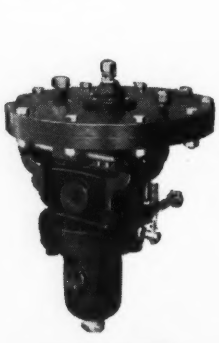
Steam pressure reduction and desuperheating control

Steam temperature control (superheat)

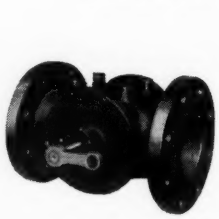
Removal of oil, moisture and solids from exhaust steam



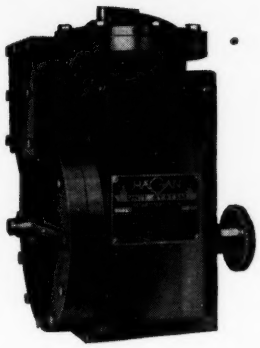
TYPE "F"
TOTALIZER



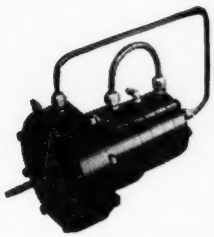
DIFFERENTIAL
TRANSFORMER



V PORT
BUTTERFLY
VALVE

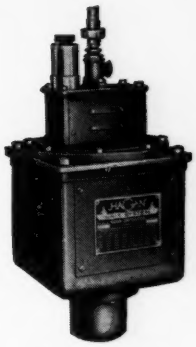


VARIABLE RATIO REGULATOR



MICRO-POSITIONER

RECEIVING REGULATOR



DIAPHRAGM REGULATOR

HAGAN *equipment*

Removal of oil and moisture from compressed air

Control of separately fired superheaters

Flow control (liquids and gases)

Flow measurement of liquids and gases with pressure and temperature compensation

Gas mixing control

Fuel-air ratio control

High temperature regulation

Remote manual or automatic control

Recovery of steam from continuous blowdown systems

Program control

Oil burner control

By-pass damper control for air preheaters

Feed water heater pressure and temperature control

Liquid level control

Control of multi-speed motor drives

Safety protection for gas or pulverized coal firing

Steam jet refrigeration control

Force measurement and control

Measurement and control of thrust and torque

We will be glad to supply full information concerning any of these applications or pieces of equipment.

Hagan Corporation, Hagan Building, Pittsburgh 30, *Pa.*

THERMOSTAT

HAGAN
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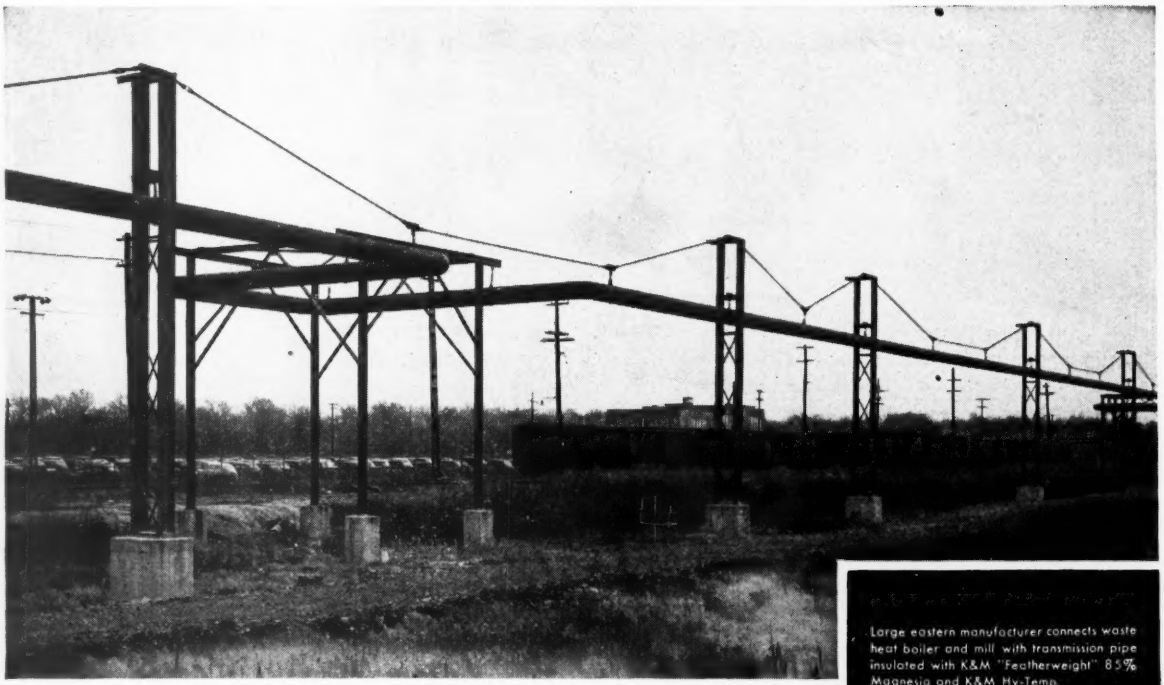
HAGAN CORPORATION

BOILER COMBUSTION CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
THRUSTORQ FORCE MEASURING DEVICES



Large eastern manufacturer connects waste heat boiler and mill with transmission pipe insulated with K&M "Featherweight" 85% Magnesia and K&M Hy-Temp.

Superheated steam travels nearly 2 miles

Another job for K&M "Featherweight" 85% Magnesia

Here is a real job for insulation. A 16" superheated steam line almost two miles long at 275 pounds pressure and a temperature of approximately 650°F. Just another case where 85% Magnesia and Hy-Temp Insulation were selected to give maximum results under exacting circumstances.

The pipe line illustrated above presents one of those extreme conditions where insulation is called upon to minimize heat losses with seasonal temperature changes varying from zero to 90°F. In this instance a 3-ply outer covering of Asbestos Roofing Felt is used as a protection against the elements.

K&M Distributors, located strategically throughout the country, are experts on the application of K&M insulation materials. Let them help you gain substantial savings in your plant. Write for full details.

KEASBEY & MATTISON
COMPANY • AMBLER • PENNSYLVANIA

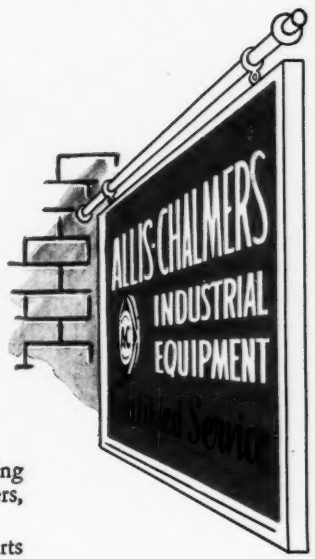
Nature Made Asbestos—

Keasbey & Mattison has made it serve mankind since 1873.

DIAMOND ANNIVERSARY
1873 1948
K&M
KEASBEY & MATTISON CO.

"Certified" Service

AN ADDED REASON FOR INVESTING IN ALLIS-CHALMERS MOTORS!



IT MEANS: 1) *Better, Faster Service.* Independent local repair shops are now being selected and authorized to service and repair Allis-Chalmers Motors, Transformers, Controls, Pumps — and "Certify" them as to workmanship.

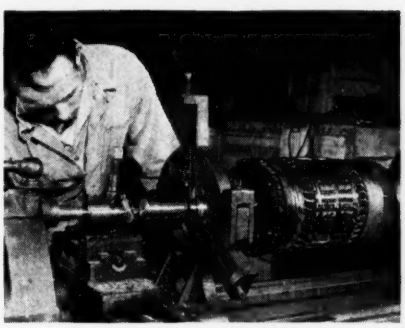
2) *Finest Parts and Workmanship.* Shops use genuine Allis-Chalmers repair parts — or parts of equal quality; and are given complete service information, including factory procedure and drawings where necessary.

3) *Friendly Service.* Every Allis-Chalmers "Certified" Service Shop has been selected on the basis of its reputation in its community. It's the kind of company you *like* to do business with!

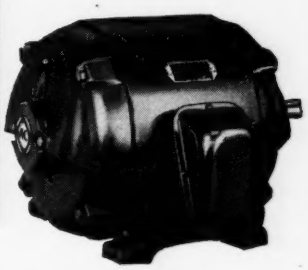
How can you get this service? For the present most "Certified" Service Shops are located in the larger U. S. industrial areas . . . but they're expanding rapidly. Call your nearby A-C District Office or Authorized Dealer for closest recommended shop. ALLIS-CHALMERS, MILWAUKEE 1, WIS.

MANY SIZES, RATINGS OF ALLIS-CHALMERS STANDARD SQUIRREL-CAGE MOTORS ARE NOW AVAILABLE FROM STOCK. CHECK YOUR AUTHORIZED A-C DEALER, OR DISTRICT OFFICE FOR DETAILS.

FINER, FASTER, FRIENDLIER SERVICE FOR INDUSTRY!



The A-C Supply Company of Cuyahoga Falls, Authorized Allis-Chalmers Dealer and newly-appointed "Certified" Service Shop, is staffed and equipped to give prompt, efficient, top-quality repair and service aid to customers in the greater Akron industrial area. Typical of the kind of "Certified" Service organizations being selected throughout U.S.

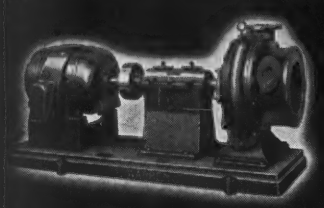


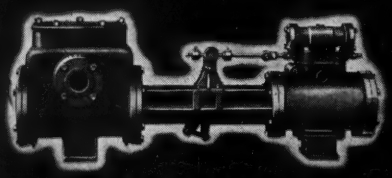
A 2506

ALLIS-CHALMERS

One of the Big 3 in Electric Power Equipment—Biggest of All in Range of Industrial Products

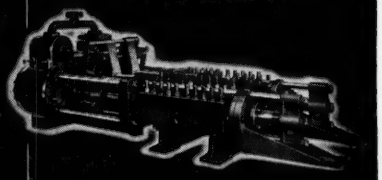
Warren Stock Pump
Type 5-SOD-15 . . . 12" suction nozzle





Warren Steam Heat
Vacuum Pump

Warren Horizontal Duplex
Hydraulic Pump



WARREN PUMPS

Maintain efficiency
Operate at low cost
Are long-lived

CENTRIFUGAL

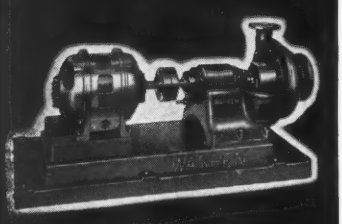
Single and multi-stage
Pressure range: 0 to 1200 P. S. I.
Capacities: 0 to 50,000 G. P. M.
Types: Horizontal and Vertical
Impellers: Open or enclosed
Casings: Horizontal or Vertical Split, cast iron or bronze
Bearings: Sleeve or ball-bearing

RECIPROCATING

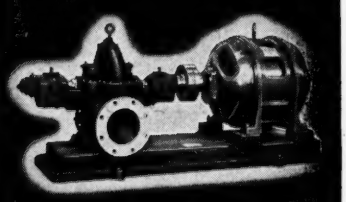
Horizontal and Vertical single piston
Horizontal and Vertical duplex piston
Single and Duplex Outside Packed Plunger
Single, Duplex and Compound Hydraulic
Steam Heat Vacuum
Automatic Pump and Receiver, etc., etc.,

Send your pumping problem to us; our Engineers will recommend the right pump for the job.

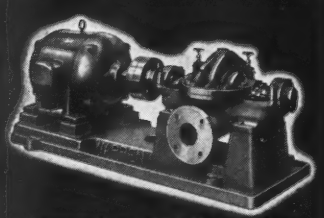
P 14



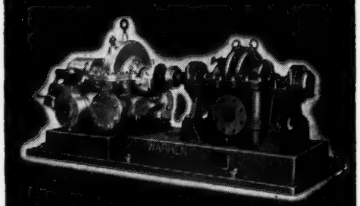
Warren Type "L" Single-Stage
Single-Suction Liquor Pump



Warren Double Suction Pump
Single Stage



Warren Type DBL, Single-Stage
Double Suction, Centrifugal Pump

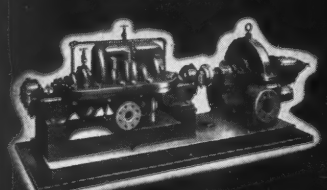


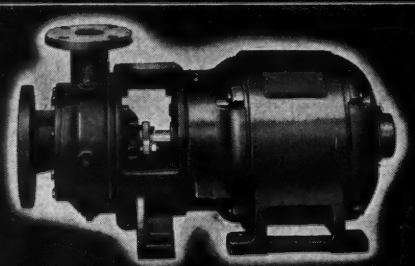
Warren Two-Stage Volute
Centrifugal Pump

WARREN STEAM PUMP COMPANY, INC.

WARREN, MASSACHUSETTS

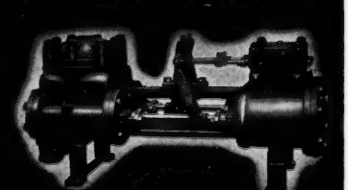
Warren Type TM, 4 and 6 Stage
Centrifugal Pump





Warren "Compacunit"—4 Types—42 Sizes

Warren Horizontal "Realwear"
Duplex Piston Pump



Tags that tell a story!

The story: When a famous producer of power re-orders

FLY ASH COLLECTORS — INDUCED DRAFT FANS
FORCED DRAFT FANS — GYROL FLUID DRIVES

over all these years, it's a sure sign of customer satisfaction.

Yes, and it's further proof that American Blower products maintain their popularity with old users while winning new users.

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CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONT.
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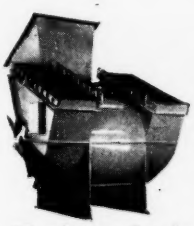
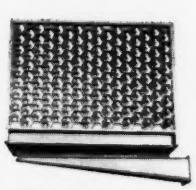
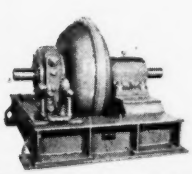


HS and Sirocco Fans for forced or induced draft in all types of power plants.



ST Fly Ash Precipitators—especially for power plants burning pulverized fuel.



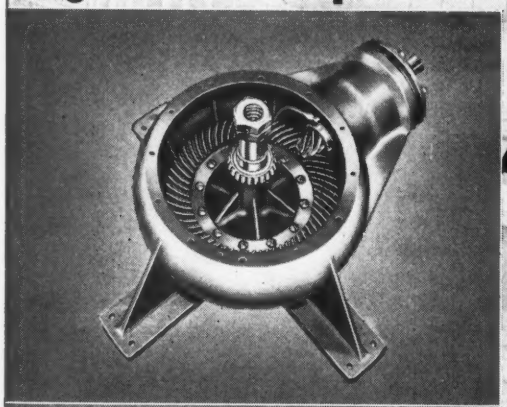
Type VS Gyrol Fluid Drive—for adjustable speed control of mechanical draft fans.

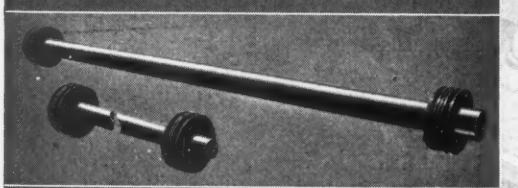
AMERICAN BLOWER

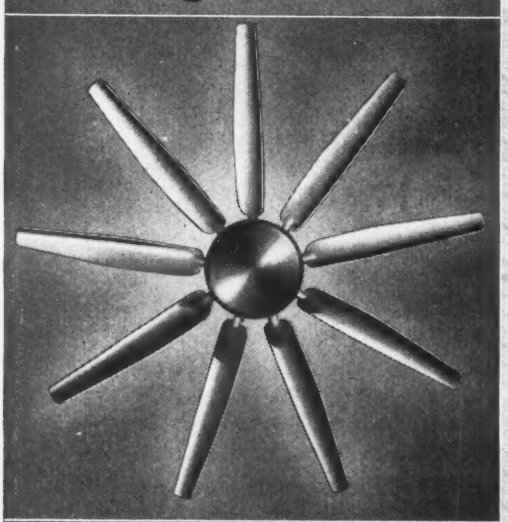
MARLEY MECHANICAL EQUIPMENT

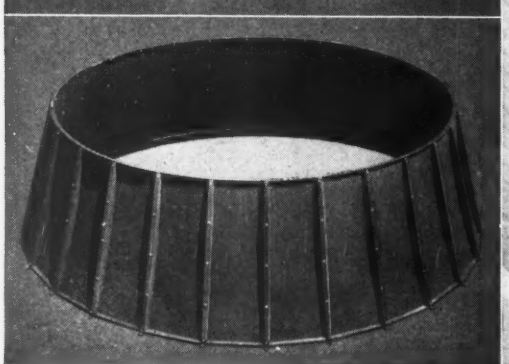
Engineered Specifically for *Your*

Double-Flow COOLING TOWERS









Mechanical equipment used on Double-Flow towers is Marley-designed for cooling tower service exclusively. Marley equipment is built to do just one job . . . move maximum volume of air with minimum horsepower and maintenance. Installations the world over prove the practical success of Marley designed equipment to do this job; do it better and more economically . . . And all Marley equipment is built in a range of sizes and materials to fit precisely the requirements of each application. Every Double-Flow installation is provided with the proper mechanical components to fulfill the guaranteed performance of that tower . . . and do it economically.

GEAREDUCERS—Designed for smooth power transmission over an extra long service life. "Upset" molychrome gears; tapered roller bearings; positive lubrication. Built in complete size range.

DRIVE SHAFTS and UNIVERSAL JOINTS—Shafts are of heavy tubular steel with steel yokes. Lengths for every fan diameter. Universals are flex discs—corrosion proof, need no lubrication; factory balanced and sized for the job.

FANS—Cast aluminum alloy in 6-, 9- and 12-blade models. All have adjustable pitch. Stainless steel fans are also available.

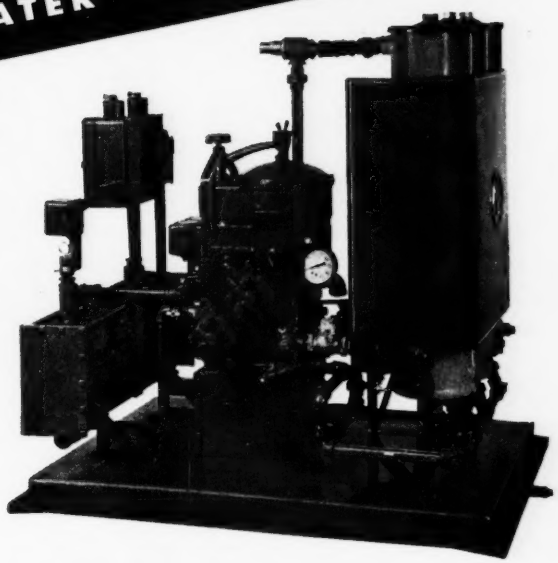
FAN CYLINDERS—Built of non-corrosive material and designed with venturi throat for minimum air entrance loss and turbulence. Sized to fan requirement: high enough for safety, low enough for inspection.

MARLEY COOLING TOWERS

THE MARLEY COMPANY, INC. • KANSAS CITY 15, KANSAS

3 Out!

DIRT · WATER · COLLOIDAL CARBON



THE DE LAVAL "Puri-Filter" removes ***all three*** major contaminants of Diesel lubricating oil: dirt, water and colloidal carbon. The first two are separated from the oil by centrifugal force in the bowl of the De Laval Oil Purifier — the water being discharged continuously. The colloidal carbon is filtered out of the purified oil by the Fram Filters.

The De Laval "Puri-Filter" combines the De Laval "Uni-Matic" Oil Purifier and Fram "Filcron" Filters. Because the combination unit gets rid of all contaminants down to one micron in size, and likewise keeps the oil completely free of moisture, it is the most effective means ever devised for protecting Diesel engine bearings.

Crank cases remain clean when Diesel oil is "Puri-Filtered". Write for Bulletin DL-1, which gives additional details.

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165 Broadway, New York 6 427 Randolph St., Chicago 6
DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 5
THE DE LAVAL COMPANY, Limited, Peterborough, Ont.

DE LAVAL *Oil Purifiers*

FOR DIESEL LUBRICATING OIL

this label . . .

Permanent Guarantee of High, *uniform* Chemical Performance

WATER TREATMENT:
TEST EQUIPMENT
SERVICE
CHEMICALS

ION EXCHANGE MATERIALS

SPECIAL POWER PLANT and PROCESS CHEMICALS

Whether you use a bag or a trainload of Nalco chemicals, there is security in *knowing you will get the results your Nalco Representative has promised.*

Controlled plant production equivalent to laboratory standards, means that Nalco Products are symbolic of dependability. Nalco results are assured by painstaking attention to details when making recommendations for water treatment procedures in each plant surveyed.

If you do not already have the Nalco System at work in your plant, a Nalco Survey may be a start toward permanent water treatment security. Ask your Nalco Representative for details, or write.

NATIONAL ALUMINATE CORPORATION
6224 W. 66th Place, • Chicago 38, Illinois

Canadian inquiries should be addressed to Alchem, Limited, 555 Eastern Avenue, Toronto, Ontario

Nalco

Serving Industry through Practical Applied Science

HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail.

BOILERS, ACCESSORIES

1 **Low Set Ram Feed Stoker**—Bulletin 400, 12 pages, contains a complete description of the stoker made by this firm for industrial boilers and furnaces. Component parts are illustrated to point out features. Controls are explained. Installation drawings and photos show how it may be applied. Canton Stoker Corp.

2 **Ball Type Pulverizer** — Bulletin G30-A, 4 pages, describes and illustrates with disassembly photos, cutaway drawings, application sketches, and coal flow diagrams, the coal pulverizer made by this firm. Pertinent information is given. Babcock & Wilcox Co.

3 **Boiler Water Level Control** — Bulletin No. 479, 8 pages, presents the story of the boiler water level control at a large New York paper mill. Close-up photos show how the controls and valves are connected and their relation to other parts of the boilers. Northern Equipment Co.

4 **Plumbing and Heating Replacement Parts**—Revised Catalog D, 98 pages, is the complete catalog of this firm which makes and markets replacement parts for a wide line of plumbing and heating fixtures. J. A. Sexauer Mfg. Co., Inc.

5 **Oil Burners** — Bulletin No. 111 describes the wide range mechanical atomizing feature of these burners and illustrates the discussion with equipment and application photos, and with cross-section blueprint drawings of Types A and AB mechanical atomizers. Peabody Engineering Corp.

6 **Combination Gas and Oil Burners**—Bulletin No. 205, 4 pages, describes and illustrates the combination oil and gas burners made by this firm. Equipment and application photos and a cross-section blueprint drawing of the burners with Types A and AB wide range mechanical atomizers serve as illustrations. Peabody Engineering Corp.

7 **Selecting, Locating, Unit Heaters** — Catalog No. 147, 52 pages, is a book to help in selecting and locating unit heaters. Listed and pictured are the various models and sizes available and the construction of these units. Typical installations illustrate varied applications. Basic hot water and steam capacities are presented for corresponding pressures. Sketches show detailed application methods. Given are; mounting height and heat throw data, heat loss calculations, locating units to utilize construction of building, piping suggestions, piping arrangements, motor wiring and control. Dimension drawings and tables are given for models. Modine Mfg. Co.

8 **Desuperheaters** — Bulletin 6-D, 8 pages, contains illustrations and data on the SK venturi type desuperheaters, surface absorption type, and the spray type, together with diagrammatic drawings and pertinent technical data. Dimension tables and a selector chart are given. Schutte and Koerting Co.

9 **Industrial Diatomaceous Silica** — Form No. A236, 20 pages, is an explanation of the product of this firm that starts with the extraction of the product through the processing to the many and varied uses for it in industry. End uses of product include; high temperature insulation, filters, paper fillers, paint flatter, catalyst carrier, asphalt fillers, concrete admixture. Eagle-Picher Co.

ELECTRICAL

10 **Fabricated Squirrel-Cage Induction Motors** — Bulletin 7000-2, 4 pages, contains 19 illustrations and a line drawings showing construction details, of these motors built in sizes from 150 to 1000 hp. Elliott Co.

11 **Renewable Fuses** — This 16 page pocket booklet describes and illustrates the construction and important features of the renewable fuses made by this firm. Prices, capacities, dimensions, are given. Company name has changed from Ware Brothers to Ware Fuse Corp.

12 **Time Delay Relays** — Bulletin 362 4 pages, describes and illustrates the relays made by this firm of the motor driven type. Photos of the relay and many wiring diagrams plus technical information concerning capacities and capabilities are given. Ward Leonard Electric Co.

13 **Synchronous A C Generators** — Catalog section 800, 4 pages, contains many photos of these generators in disassembled condition so that construction may be understood. Up to 375 kva available. Columbia Electric Mfg. Co.

14 **Matched Electric Motor Parts** — Form 1871, 36 pages, is the complete catalog on matched motor parts made by this firm. Described and illustrated with photos, performance charts, capacity and specification tables are the variety of motor parts divided into three groups. Robbins & Myers, Inc.

MECHANICAL POWER TRANSMISSIONS

15 **Gearmotors** — Bulletin 1815, 16 pages, describes and illustrates gearmotors made by this firm. Given are; features of design, selection information, load classification table. Types of mounting, selection tables, dimensions, slide rails. Also presented are other power transmission units. Link-Belt Co.

16 **Over-Center Clutches**—Bulletin SD-OC, 12 pages, explains and illustrates the construction and application of these small diameter over-center clutches. Capacity, hp ratings, size, release travel, and specifications are given for these units in the various sizes in which they are made. Dimensional drawings provided. Morse Chain Co.

17 **Hydraulic Couplings** — Bulletin No. 136, 12 pages, contains the story of hydraulic couplings and the claimed advantages for industrial engine and motor applications. Exploded views, phantom views, performance charts, dimensional drawings and tables help convey the story told in the text. Twin Disc Clutch Co.

18 **Belting, Transmission and Conveyor** — This 6 page bulletin is replete with photos and drawings showing in detail the function and scope of the products of this firm. Many applications are shown in which the transmission and conveyor belts can be used. Buckner Process Co.

PACKING, GASKETS, SEALS

19 **O-Ring Engineering Manual** — This 8 page manual contains tabulations of compound specification, dimensional standards, data on applications, and installations, plus drawings show typical problems of O-Ring usage. Crane Packing Co.

20 **Metal and Asbestos Gaskets** —This 32 page catalog presents the many types of gaskets made by this firm. Photos, construction sketches, dimensional drawings and tables, capacity tables, data on areas of circles, steam table, water head table, and temperature conversion table are the illustrations that make up the bulk of this book. Spiral wound gaskets are discussed. United States Gasket Co.

21 **O-Ring Seals** — Catalog No. 901, 8 pages, contains drawings of sealing methods, groove dimensions, gland diameter, a dimension table of product O-rings, and specifications. Parker Appliance Co.

INSTRUMENTS, CONTROLS

22 **Testing Instruments** — Bulletin 4-2, 4 pages, describes several of the instruments made by this firm and instruction manuals offered on their ohmmeter. James G. Biddle Co.

23 **Graphic Meters** — Bulletin No. 35, 16 pages, pocketsize, presents the instruments made by this firm for keeping a check on equipment so that breakdowns can be avoided. Esterline-Angus Co., Inc.

24 **Rotameters** — This is the full catalog of the flowmeters made by this firm. Complete information except prices is given for these instruments. Capacity tables, dimensions, plan drawings, and mounting methods are provided. Brooks Rotameter Co.

25 **Watthour Meter** — Bulletin GEC-350, 16 pages, describes the construction and principle of operation of the new type I-50 single phase watthour meter. Cutaway photos and cross-sectional drawings are used to explain the construction. Performance charts and tables given. General Electric Co., Appliance Dept.

26 **Timing Motor** — Bulletin No. 10A, 4 pages, describes the construction and operation of the self-starting synchronous timing motor, Type SX. Motors are designed for industrial applications in instruments and controls. Table, dimensions, and a cutaway photo are illustrations. R. W. Cramer Co., Inc.

PROPERTY MAINTENANCE

27 **Roof Repair** — Bulletin B. U.-49A, 40 pages, is full of on the spot photos and sketches showing some of the poor conditions and how they should be remedied. The sketches show how the roofing materials and flashings should be applied in the proper order. Many of the photos show just what to look for on roofs of various materials and point out how these conditions can cause trouble. Johns-Manville, Corp.

28 **Acids, Alkali Resistant Tank Lining** — This 4 page bulletin describes the tank lining made by this firm for application to tanks containing acids or alkali. Application instructions are given for the product. Available in colors. Nukem Products Corp.

29 **Oil Absorbent for Floors** — Bulletin FB10, 6 pages, explains how the product soaks oil and grease from unsafe

AUGUST, 1948

POWER GENERATION
53 W. Jackson Blvd.
Chicago 4, Illinois

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City.....State.....

floors. Step-by-step photos show how it is applied and used. Safety and Maintenance Co., Inc.

30 **Built-Up Roofing Materials** — Form 5597, 28 pages, is the specification book for the roofing materials made by this company. All types of materials and roofs are considered and the approximate quantity needed complete with pitch of roof, surfaces, insulation, and pertinent notes referring to each type of construction is given and discussed. Philip Carey Mfg., Co.

31 **Laying Steel Mat Flooring** — Form 142, 20 pages, is the instruction bulletin on how to lay their makes of steel mat flooring and how to finish it off with the proper mixture if a smooth floor is desired. Step by step detailed photos show how the floor should be prepared, how the mat is laid and joined, filling with mastic or concrete depending on old base. Wm. F. Klemp Co.

32 **Roofing Insulation** — This 12 page bulletin explains the product and its application. Dew point charts, U value chart, heat transmission chart, and a list of physical properties make up the technical data contained in this book. Photos are interspersed showing how the insulation is applied in relation to other materials. Pittsburgh Corning Corp.

33 **Floor Patching** — Bulletin 15M-K, 4 pages, describes the product that is made for patching floors of concrete, stone, composition, steel or wood indoors. Step by step photos show method of preparing the floor and applying the patch. Flexrock Co.

34 **Non-Skid Floor Treatment** — This 4-page folder tells the story of the treatments made by this firm to make floors non-skid. The products are described and explained with cautions that must be observed. The product to be used with each type of floor is listed. Walter G. Legge Co., Inc.

35 **Paints and Coating Materials** —This 6 page folder describes the Duramite pH product of this firm. This coating is said to be chemical resistant, and the Chemicals it resists are listed. Surface preparation, application, and drying of the coating is discussed. The types available are listed. Morton Chemical Co.

36 **Industrial Glass Building Block** — Bulletin 7c-2, 28 pages, contains many application and installation photos and drawings to convey the story of what glass block can do in industry. The various designs of block are given with pertinent information. Details of construction with block are given. American Structural Products Co.

PUMPS, EJECTORS

37 **Helical Rotor Oil Pumps** — This catalog sheet describes and explains the oil pumps that feature a helical rotor for claimed smooth, pulseless, axial flow. Exploded views show the few parts that are needed for this pump. Specification table and performance chart are given. Syntron Co.

38 **Centrifugal Pumps** — Bulletin No. 4711, 36 pages, presents the most recent developments in a line of horizontal and vertical shaft centrifugal pumps. The parts of the pump and their construction are explained and illustrated. Installations to which they may be applied are shown in sketches and explained in the text. Capacity, size, and dimensional drawings and tables are given. Nagle Pumps.

39 **Air, and Liquid Handling Pumps and Equipment** — Bulletin G-82, 4 pages, illustrates and briefly describes this firm's entire line of products. Text covers the capacity and pressure ranges of the various sizes and types available in both standard and special units. These include: centrifugal and rotary positive blowers and exhausters, positive displacement meters, rotary liquid and vacuum pumps, and inert gas generators. Roots-Connersville Blower Corp.

40 **Positive Displacement Pumps** — Form No. 1751A, is a catalog sheet which presents the helical rotor pumps made by this firm. A disassembly photo depicts the parts and construction of the pump clearly. Moyno Pump Div., Robbins & Myers, Inc.

41 **Pneumatic Sewage Ejectors** — Bulletin 4004, 20 pages, presents the mechanically controlled pneumatic sewage ejectors with text, application photos, cutaway drawings, air volume and pressure table, dimensional drawings and tables, piping layout diagrams, and line and plan drawings. Yeomans Brothers Co.

42 **Metering Hydraulic Drive Pump** — Bulletin PK-47, 4 pages, describes with cross-sectional drawing, photo and capacity table, the pump made by this firm for hydraulic drive for metering and proportioning. Hills-McCanna Co.

43 **Packaged Boiler Feed Units** — Catalog Section 202, 4 pages, describes and illustrates the complete units and component parts. Selection table to use in choosing a unit to suit a boiler size and pressure is provided. Roy E. Roth Co.

COOLING TOWERS

44 **Water Cooling Towers** — Bulletin AQ-48, 4 pages, explains the construction of the towers made by this firm. Complete description of all component parts is given and some illustrated. Dimensions for the 7 series available are given and a capacity table is presented. The Marley Co., Inc.

45 **Vertical Air Discharge Cooling Units** — Catalog No. 448, 8 pages, contains illustrations, diagrams, and dimensions, with full descriptions of these large units which are available. Capacities of units for cooling or condensing steam are given. Individual parts are detailed. Young Radiator Co.

46 **Mechanical Draft Cooling Towers** — Catalog section 37, 4 pages, utilizes complete and partial equipment photos, plan drawings, and tables of capacities as illustrations to explain the construction and operation of these cooling towers, 2K-W. Binks Mfg., Co.

WATERS, OIL, CONDITIONERS, FILTERS

47 **Boiler Water Conditioner** — This 4 page bulletin explains the dangers of untreated boiler water and then explains how a formula prepared by this firm to suit a particular boiler and water will help to eliminate scale formation, establish corrosion control, inhibit pitting, and promote the production of clean steam, as claimed by this company. Alladdin Laboratories, Inc.

48 **Gas Adsorber** — Bulletin No. 113A, 2 pages, describes and explains the gas adsorber for compressed air lines made by this firm. Drawings, photos, capacity table, and pressure table are provided. W. B. Connor Engineering Corp.

49 **Slime and Lime Scale Control** — Form 6261R, 4 pages, describes the action the chemical solution made by this firm has on slime and lime scale in evaporative condensers and coolers. The steps to be followed when preparing to use and when using the solution are outlined. Oakite Products, Inc.

50 **Liquid Precipitation** — Bulletin 2204, 12 pages, describes and illustrates the precipitator made by this firm for the removal of impurities from a liquid by precipitation, adsorption, settling and upward filtration. Cutaway photos and cross-sectional drawings show the principles of operation. The Permuit Co.

51 **Boiler Preservative** — This 6 page folder describes the boiler water treatment compounds created by this firm to suit a particular boiler and water. The product, the service, and the research offered are discussed and explained. Garratt-Callahan Co.

52 **Air Intake Filters** — Bulletin SIF, 8 pages, describes and illustrates the air intake filters for internal combustion engines, compressors, blowers, motors and generators. The parts of the filters are depicted and explained separately. Selection tables and charts are provided. Capacities are noted. Dollinger Corp.

PIPING, VALVES, TRAPS

53 **Engine Stop Systems** — Bulletin 8D, 4 pages, describes and illustrates technical data on emergency trip valves and auxiliary equipment designed to operate by either mechanical or electrical means. Dimensional drawings and tables are given for the various sizes of valves offered. Schutte and Koerting Co.

54 **Pipe Unions** — This 4 page bulletin presents the line of octagonal unions made by this firm in many different types. These unions are for 300 lb. SWP with ground joints. All types are illustrated and listed as to weight, male or female, angles, sizes, and price is given. The Corley Co., Inc.

55 **Insulated Pipe Units** — Form 4713, 12 pages, depicts the growth of a central steam heating system in the center of a cultural group of buildings. Detailed is the manner in which the product was used to protect the underground steam line running between the several buildings. Ric-Wil Co.

56 **Air Line Check Valves** — Bulletin 509, a catalog sheet, describes the check valve for air lines made by this firm. The principle parts are pictured separately and assembled. Pennsylvania Pump & Compressor Co.

57 **Stainless Steel Piping** — This booklet of 24 pages tells why stainless should be used and where. Drawings, photos, sketches, tables of wall thicknesses, chemical composition, selection of pipe joints, welded fabrication, are illustrated and explained. Tube Turns, Inc.

58 **Steam Traps** — This four page bulletin gives a short discussion of the five different types of steam traps with a sketch to illustrate the type. The merits of each type of trap are discussed by this firm which makes steam traps. V. D. Anderson Co.

59 **Bronze Gate Valves** — Circular No. 534, 12 pages, presents the new line of bronze gate valves for 200 lb service made by this firm. Illustrated with cutaway and exploded drawings to show construction and operation. Dimensions are given. Lunkenheimer Co.

TOOLS

60 **Air Driven Electric Generator** — Form 5032, 4 pages, describes the small generator driven by an air turbine for use in locations where long electric extensions might prove dangerous. Ingersoll-Rand Co.

61 **Castings Repair** — Bulletin No. 104, 24 pages, describes the process of this firm for repairing cracked and broken castings. The story of many actual repairs is told with photos. Sketches show the 4 different variations of the method of repair. Metalock Casting Repair Service, Inc.

62 **Boiler Tube Expanders** — Circular No. E3, 4 pages, describes the several tube expanders made by this firm. Listed are tables of sizes. Price lists are also included if desired. These tube expanders are made in many styles for every purpose. Richard Dudgeon, Inc.

63 **Masonry Drill** — Bulletin HD-1147, 4 pages, presents the masonry and rock drill that can also double for chipping tool, scaling hammer, or light riveter. Specifications are given, and most of the auxiliary parts and accessories are illustrated and listed. Cleco Div., Reed Roller Bit Co.

64 **Gear and Wheel Pullers** — This folder explains, illustrates, lists prices and important points of the 2 and 3 prong pullers for wheels, gears, pulleys, made by this firm. Sizes and dimensions are given for each model. Armstrong-Bray & Co.

65 **Jacks** — Bulletin 203-A, 4 pages, describes and gives specifications for all the many different types of jacks made by this firm. Prices are given for each type, size, and capacity. Duff-Norton Mfg., Co.

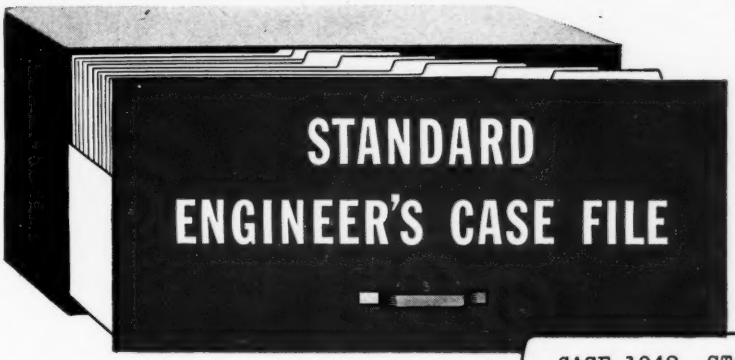
66 **Tool Sharpening** — Booklet N-212, 48 pages, contains useful information on how to sharpen tools and describes how each type of tool should be handled and the type of stone and oil to use on it. Behr-Manning Div., Norton Co.

MISCELLANEOUS

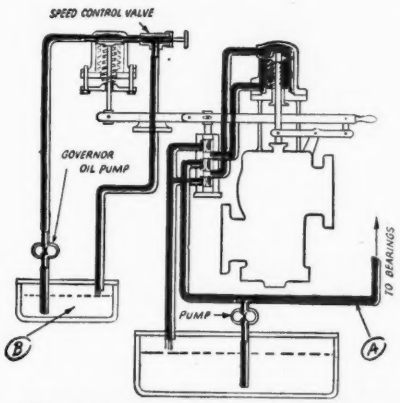
67 **High Temperature Alloys** — Bulletin F-6612, 87 pages, contains available data on this firm's alloys. In addition to a general description of each alloy there are tables giving chemical composition and physical properties. Mechanical properties are presented in both tabular and graphic form. Short-time tensile properties and stress-rupture properties of all the alloys are also compared in graphs. Haynes Stellite Co.

68 **Sump Tank Cleaners** — Bulletin No. 130, 4 pages, describes and illustrates the sump cleaner made by this firm for grinding machines and machine tools. The portability of the unit is featured as are the construction and principles of operation. Photos, dimensional drawings, and specifications table make up the illustrations. Spencer Turbine Co.

69 **Diesel Electric Locomotives** — Bulletin GEA-4909, 8 pages, presents the several different models and sizes of locomotives made by this firm for industrial switching. Table and charts of performance on grade and with loads is given. Apparatus Dept. General Electric Co.



CASE 1048—STOPPING RUSTING, LACQUERING, SLUDGING IN STEAM TURBINES.



VARIABLE-SPEED OIL-RELAY GOVERNOR

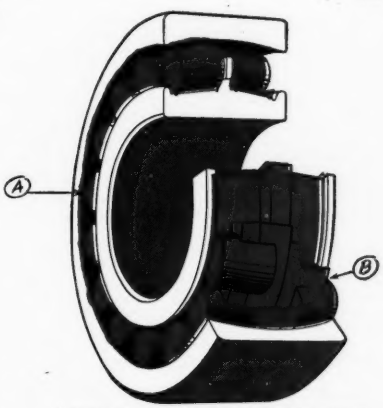
Charges of inhibited Calol OC Turbine oil in various size turbines gave service many times longer than normally obtained with straight-mineral oils. Use in large and small units ... ring-oilers, circulating oil lubricating systems and oil-actuated governor relay systems. Comes in four grades: 9, 11, 15, 19.

A. Contains highly effective corrosion inhibitor and has excellent metal-wetting ability. Keeps moisture in oil systems from contacting metal.

B. Oxidation inhibitor resists deterioration of oil and sludge formation caused by heat, moisture, air, dirt ... prevents plugging of oil lines.

Calol OC Turbine Oil in regular service showed no increase in acidity after several years ... turbine parts remained in same condition as when installed ... water and solid contaminants separated readily from oil in centrifuging or filtering systems.

CASE 1050--PROVIDING FLUID LUBRICATION IN ANTI-FRICTION BEARINGS WITHOUT LEAKAGE.



HEAVY-DUTY ROLLER BEARING

Heavy-duty industrial roller bearings started easier and ran freer when lubricated with Calol Grease BRB-340. Specially-made for all anti-friction bearings. Apply with grease gun or by packing.

Has unusual ability - softens around roller and balls in bearings to oil-like viscosity but remains firm on outer parts. Resets quickly so oil swept aside by moving bearing parts keeps firm outer seal of grease intact.

A. Soft consistency around moving parts of bearings lowers starting torque and reduces internal friction.

B. Firm grease forms seal that helps prevent leakage.

High resistance to deterioration under high speed conditions and extreme temperatures provides exceptional lubrication over extended periods of operation.

For additional information and the name of your nearest Distributor, write

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PUTS THE PROFIT IN THIS EQUATION

The log mean terminal temperature difference goes down and stays that way when chlorination goes to work and stops slime formation on the water-side surfaces of your condensers and heat exchange equipment. This means lower fuel costs, less out-of-service time, the elimination of plug cleaning, more profit.

Since even the slightest slime film means a high LMTTD, it is important that the remedy get at the basic cause of the trouble—slime forming organisms. That's just what chlorination does and here are some typical examples of the profitable results:

A southern power station realized a net annual saving in steam costs alone of $16,000 from a W&T installation.

A refinery obtained enough savings through condenser de-sliming by chlorination to pay the cost of the installation in six months.

A midwestern power company obtained savings of $11,000 in one year through cooling water chlorination.

Call your nearest W&T Representative, backed by over thirty years' experience in water treatment, for a cooling water study of your plant—there's no obligation, of course. and you may find, as so many other plants have, that the LMTTD isn't as low as it could be with chlorination.

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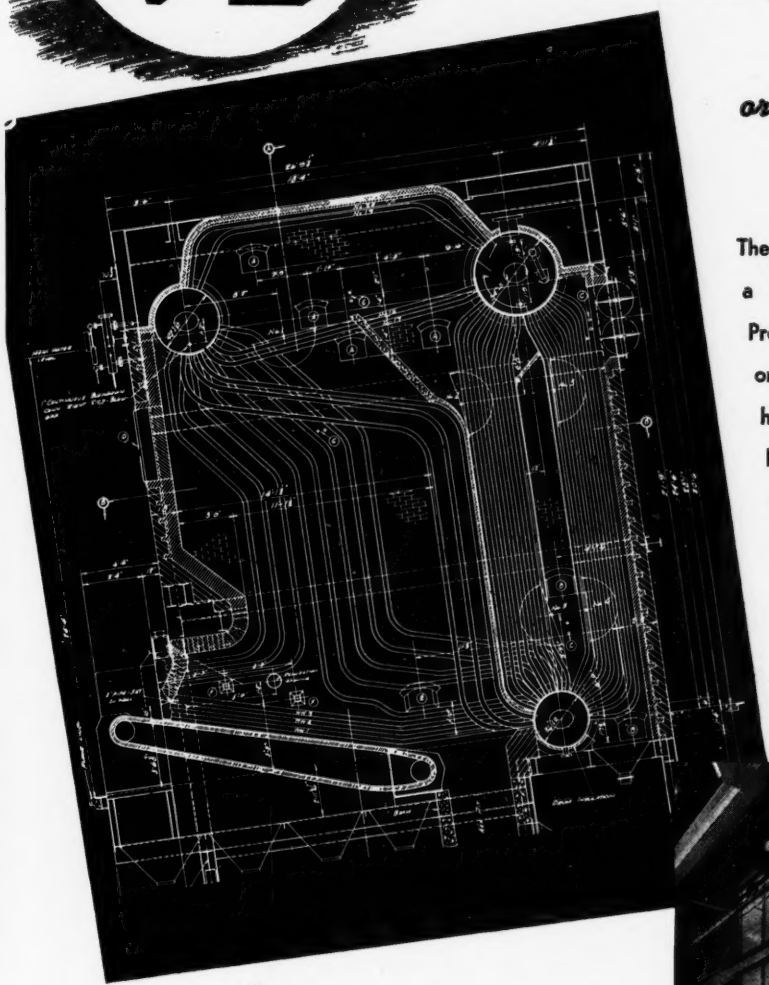
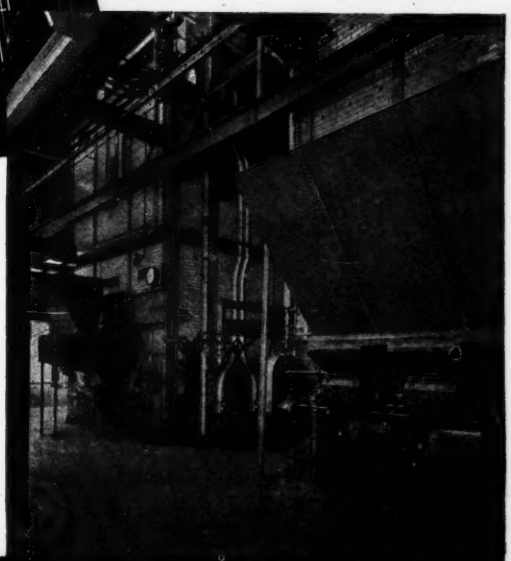
Steam Generating Units

for POWER
or PROCESSING LOADS,
and HEATING

The design provides large furnace volume and a high ratio of radiant heating surface. Proper combustion is assured with any fuel or method of firing. Superheaters, air preheaters, economizers, water walls, and soot blowers can be readily incorporated. Vogt Class VL Steam generating units are giving satisfactory service in Hotels, Sugar Refineries, Steel Mills, Furniture Factories, Distilleries, Oil Refineries, and related industries. A bulletin showing typical installations will be sent upon request.



Above:
This 90,000 lbs. steam per hour unit, designed for 475 lbs. pressure, serves the Mansfield Tire & Rubber Co., Mansfield, Ohio.



Right:
Two 515 H.P. units installed in Brown-Forman Distillers Corporation, Louisville, Ky. Plant.

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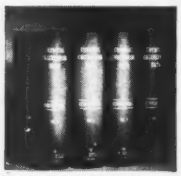
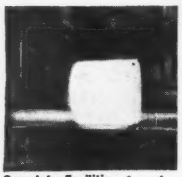
Metallurgical Research conducted continually by recognized specialists who have made major contributions in this field.



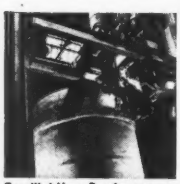
Unique Technical Backing of an extensive organization with an international reputation in both process and fabrication engineering.



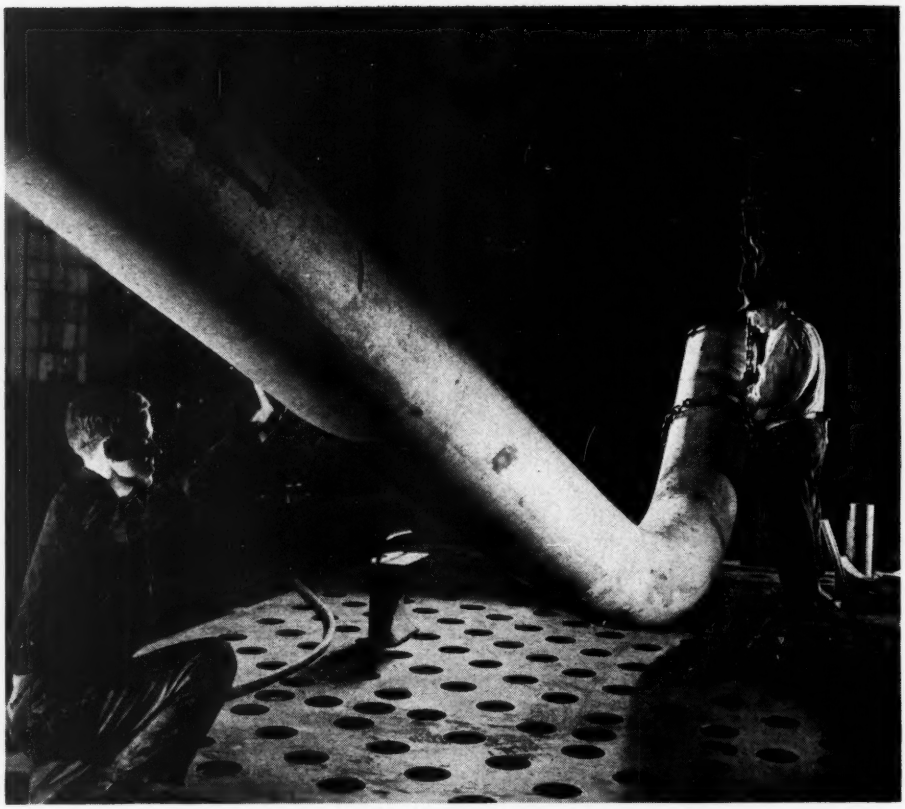
Complete Facilities for the fabrication of steel products from simple forgings to the most intricate 120 foot towers.

Quality Control embracing the constant application of the most advanced inspection methods, both visual and non-destructive.

On-Time Delivery made possible by a flexible planning group authorized to re-route work to meet promised dates.



Top Welding Performance assured by specially designed equipment and exclusive employment of master operators.



When is the best time to judge the quality of power piping?

Here is a pipe bend for a power installation—about to start on its way to you.

For its intended service, steel of the correct analysis has been specified. It has been welded under laboratory supervision and radio-graphed. It has been bent hot, with careful temperature control—*no water quenching!* And finally it's been properly heat-treated. To all intents and purposes, it is the best power-piping that money can buy.

But *is* it? That you can't tell *until it's hooked up to your equipment, ready to play its part in the steam line.*

To make the erection job match shop fabrication in quality, controls must be extended to the *job site.* Because here, stresses *set up during field welding* can produce metallurgical faults *which can affect seriously the life of both piping and connected equipment.*

For instance, knowing exactly where to apply support to piping—and how much to apply—during field welding and heat treating is one of the important control factors.

To assure that this and many other necessary precautions are taken during erection of power piping, we here at Kellogg have *integrated* our field installation service with both our shop and metallurgical laboratory staffs—providing both experienced erection technicians and the latest metallurgical know-how at the most important spot: *the job site.*

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PROCESS PIPING • FORGED AND WELDED FITTINGS . . . IN ALL STEELS, ALLOYS OR SPECIAL COMBINATIONS

"High-Spots" ON THE HIGH-PRESSURE MAP

Nearly one thousand Worthington High Pressure Centrifugal Pumps, now in boiler feed service, are a testimonial to Worthington's continuous leadership in pump design and manufacture. A long list of pace-setting Worthington design-features have helped to advance feed pressures up to 2400 psi. For example, the Elastic Seal Ring, for tight interstage joints in axially split casings, and the Metal-to-Metal Ring Type Joint in solid-case pumps.

Worthington Centrifugal Pumps Meet the Demand for Steadily Rising Boiler Feed Pressures

Each dot represents a Worthington Boiler Feed Pump rated at higher than 750 psi. Many similar Worthington installations in other countries increase the grand total.

Get the RIGHT Pump for the Job

Worthington builds Standard Centrifugal Pumps in all sizes, pressures and capacities. This most complete line offers you the widest choice . . . your one best bet for pumping-satisfaction. And you can count on Worthington engineers, backed by the longest and broadest experience in the field, for expert aid in any pumping problem. For the dependability, economy and long service-life that prove *there's more worth in Worthington*, come to Pump Headquarters. Call our nearest District Office, or write to *Worthington Pump and Machinery Corporation, Centrifugal Pump Division, Harrison, N. J.*

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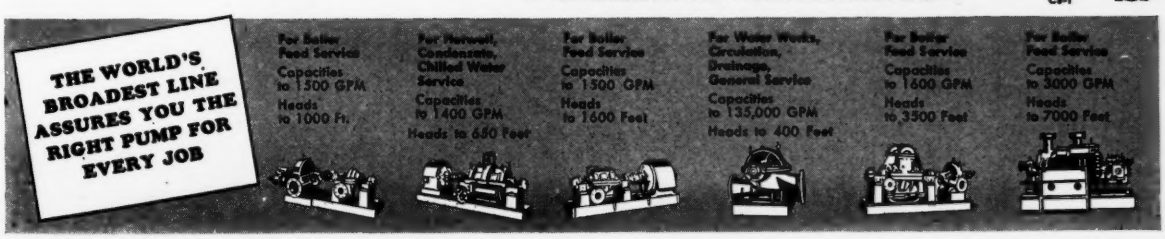
THE WORLD'S BROADEST LINE ASSURES YOU THE RIGHT PUMP FOR EVERY JOB

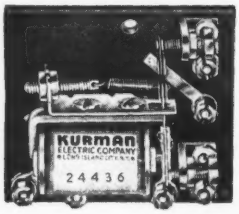

For Boiler Feed Service
Capacities to 1500 GPM
Heads to 1000 Ft.
For Natural, Condensate, Chilled Water Service
Capacities to 1400 GPM
Heads to 650 Feet
For Boiler Feed Service
Capacities to 1500 GPM
Heads to 1600 Feet
For Water Works, Circulation, Drainage, General Service
Capacities to 135,000 GPM
Heads to 400 Feet
For Boiler Feed Service
Capacities to 1600 GPM
Heads to 3300 Feet
For Boiler Feed Service
Capacities to 3000 GPM
Heads to 7000 Feet

NEW EQUIPMENT NEWS

Use the coupon below when you want further information on the equipment described on this page and following pages. Write the identifying letter or letters in the space provided, clip the coupon and send it to Power Generation, 53 West Jackson Boulevard, Chicago 4, Illinois

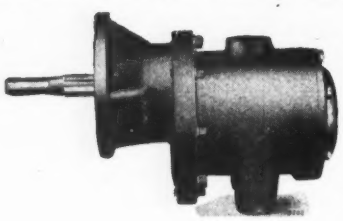
A **Split Armature Relay.** A new relay, with a split armature is being manufactured. This new 24 relay was developed for automatic controls, keying, antenna changeover, burglar alarms, and closed circuit applications.

The relay contains the following gen-



eral features: contact flexibility, magnetic circuit, u-shaped magnetic circuit of high permeability nickel alloy, especially heat treated, steep curve provides dependable constant operation at low current values. Kurman Electric Co., Inc.

B **Air Starting Motors.** Available are air motors of two sizes as starters for internal combustion engines. The air motor is keyed or splined to the Bendix or starting mechanism and the engine is cranked. The starting motors are known as the Size 9BM and Size 20BM; the former of 9 hp and the latter 20 hp at 90 psi air pressure. They are small and compact having an overall length of only $13\frac{3}{16}$ in. and $14\frac{1}{2}$ in. The air motor is of the multi-vane type and the throttle valve is of the quick opening type to give peak horsepower almost immediately. A single step spur gearing is used to obtain suitable speeds. Ingersoll-Rand Co.



C **Portable Potentiometer.** A new portable potentiometer for precise measurements of very low voltages has been announced. The potentiometer is designed for checking temperature-

measurement instruments and for the testing of rotating machines, ovens, furnaces, oil-burners, steam-driven equipment, and air-conditioning units.

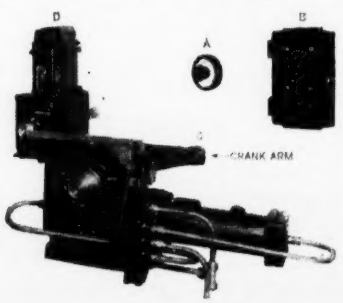
The equipment of the potentiometer, which is contained in a durable, fabric-covered luggage case, includes the galvanometer, standard cell, working batteries and rheostats for adjusting the current through the potentiometer circuit. The galvanometer, which is not built in, is furnished with a built-in transformer so the galvanometer lamp may be operated from 115 v, ac supply lines, but if field conditions dictate the transformers may be readily disconnected and the lamp operated from 4 No. 6 dry cells. This potentiometer has two ranges, 0-60 and 0-6 millivolts, either of which may be selected by means of a switch on the panel. The voltage to be measured is read on two dials, with each step on the first dial being 0.2 millivolt, and each division on the second dial, 0.001 millivolt. Meters and Instrument Div., General Electric Co.

D **Synthetic Resin Cation Exchanger.** A new high-capacity synthetic resin cation exchanger offered in bead form is announced. Its trade name is Amberlite IR-105.

The resin derives its activity from sulfonic acid groups, and may be employed either in the sodium or hydrogen cycle. The resin is shipped in the sodium form (in a moist, completely swollen condition) but can easily be converted to the hydrogen derivative by treatment with mineral acids. The specific physical characteristics of Amberlite IR-105 are: a density of 47 lb as shipped (corresponding to 1 cu ft of space in place backwashed and drained); a moisture content of 40 to 50 per cent; a wet screen grading of 16 to 50 mesh; an effective particle size of 0.4 to 0.6 millimeters; a maximum uniformity coefficient of 1.7; and voids of approximately 45 per cent. High physical stability insures against attrition losses.

Complete data on Amberlite IR-105 operational characteristics are available from the manufacturer in an 8-page report on head-loss, back-washing, bed depth, sodium and hydrogen cycle regeneration, rinse requirements, service flow rates, and exchange capacities under various common conditions. Resinous Products & Chemical Co.

E **Hydraulic Cylinder Control.** Hydraulic cylinders, with power output up to 7,500 lb, it is claimed can now be positioned with laboratory accuracy. Remote control station or stations may be installed at points 1,000 feet or more from the location of the cylinder. Accuracy of cylinder movement of 0.1 per cent is obtained. New standard control units are combined to produce this



AUGUST, 1948

POWER GENERATION

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Please have the manufacturers send me without obligation further information on the equipment indicated by the following letters:

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No waiting for most regular items at your Crane Branch or Wholesaler

Stock bins are rapidly filling up at local Crane outlets. Day by day, in valves, fittings, steam specialties, piping accessories . . . brass, iron, and steel . . . the selection keeps rounding out.

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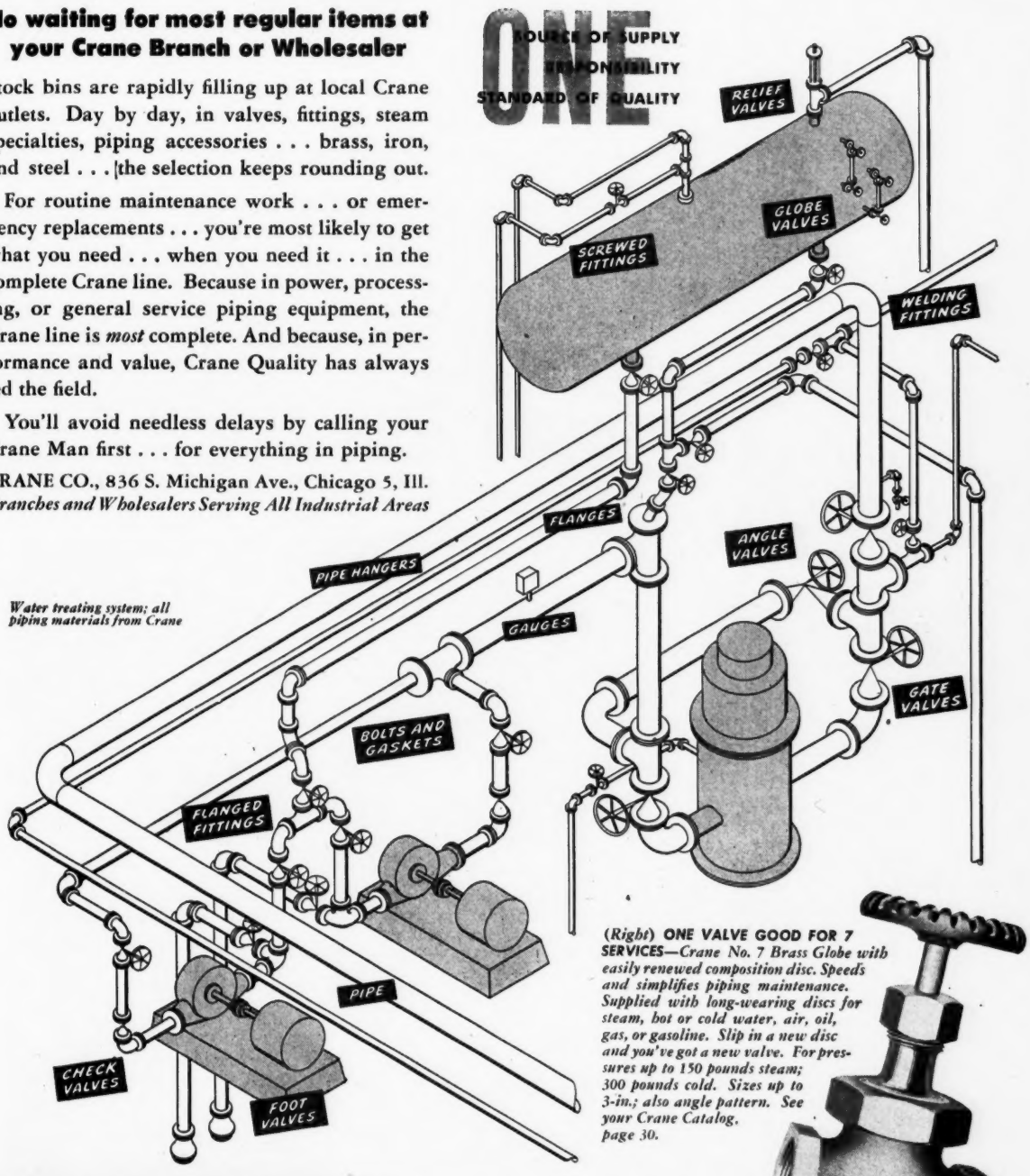
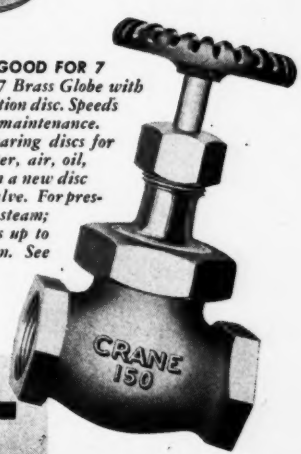


Water treating system; all piping materials from Crane



(*Right*) **ONE VALVE GOOD FOR 7 SERVICES**—*Crane No. 7 Brass Globe with easily renewed composition disc. Speeds and simplifies piping maintenance. Supplied with long-wearing discs for steam, hot or cold water, air, oil, gas, or gasoline. Slip in a new disc and you've got a new valve. For pressures up to 150 pounds steam; 300 pounds cold. Sizes up to 3-in.; also angle pattern. See your Crane Catalog, page 30.*

EVERYTHING FROM . . .

VALVES • FITTINGS PIPE • PLUMBING AND HEATING

CRANE

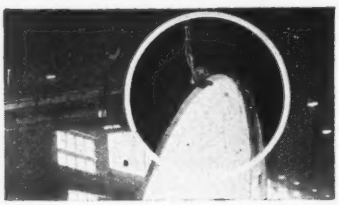
FOR EVERY PIPING SYSTEM

highly accurate, heavy duty positioning system. With this system, a small electric signal is translated into a "position of a hydraulic cylinder."

Position of cylinder crank arm can be selected at either control station A or station B. An electric signal of the position selected is transmitted to the receiver motor (D) which operates a pilot valve positioning the crank arm at any point within its 90 degree arc. The output position can be selected manually, or with minor modifications of the system illustrated, the position can be selected automatically from signals developed by plant processes or other changing operating conditions. Askania Regulator Co.

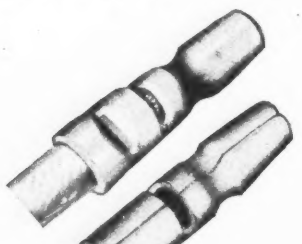
F **Sketch Sheets.** Announced are new sketch sheets with cross section ruling that will not reproduce. The sheets may be used for blueprint, black and white, or Ozalid reproductions. It is said that the best results are achieved with a fast paper. The sheets are available in two different grades. May be had with or without headings. Furnished in 50 sheet pads. Available are sheets having lines 4 by 4, 5 by 5, 8 by 8, and 10 by 10 to the inch. Oglivie Press.

G **Grip Clamp.** A simple, rapid and safe method of raising or lifting into place such items as large tanks, flanged heads, and similar articles which are usually difficult to get securely attached, can be accomplished



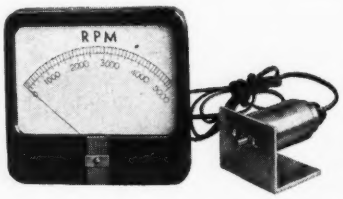
with this new grip clamp. It will lift anything that has sufficient flat surface for its jaws to grip.

H **Solderless Plug-in Terminals.** Announced is a new plug-type terminal for 16-14 wire size which provides an easy, convenient method of installing or replacing connections on



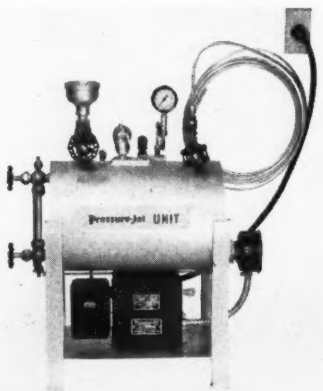
leads in electrical appliances, automotive equipment, personal aircraft, electrical equipment on machinery, and other devices. Trade marked Shur-Plug, these solderless terminals are engineered for efficiency and compactness. Application to the wire is accomplished in a matter of seconds by means of a hand tool, pneumatic hand tool, or by foot or power presses. The resulting connection has high electrical conductivity and corrosion resistance. They are for standard wire, and are designed to make perfect plug-in connections with standard female fittings. Aircraft-Marine Products, Inc.

I **Electric Panel Tachometer.** This unit is designed for use on engines, textile machines, paper machines, machine tools or on applications where a variable speed drive is used and accurate determination of the output speed is required. The unit consists of a pick up generator with a stationary armature and a small Alnico magnet rotor mounted on sealed ball bearings. There are no brushes or other wearing parts in the generator. A rectifier type meter with a D'Arsonval movement is used. This meter can be furnished in

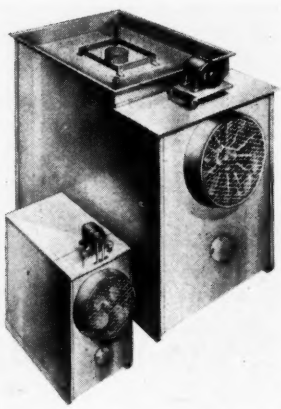


either 3 or 7 in. size and is regularly furnished in 0-1250, 0-2500 and 0-5000 rpm ranges. The meter can also be furnished with suitable calibration to give fpm, gpm or any other unit for measuring speed. The small size of the generator pick up makes it adaptable to applications where there is not sufficient room for larger units. The diameter of the generator is 1⅝ in. and with the mounting bracket the overall height is 2½ in. The length including shaft extension and electrical plug is 4½ in. The generator can be connected to the shaft whose speed is to be measured by means of a flexible coupling, chain drive, or gear drive. The meter may be located as far as 200 ft from the generator, which means that in any application it can be placed where it can be easily read. Crown Industrial Products Co.

J **Steam Return Line Treatment.** The Pressure-Jet system of corrective treatment comprises two factors: The Pressure-Jet unit and Pressure-Jet fluid. This fluid, electrically heated in the unit, is atomized into the steam main beyond the boiler at high temperature and adjusted to the pressure of the steam system. Because its temperature is higher than that of the steam into which it is atomized, the fluid is said to entrain with the steam, which, acting as a vehicle, carries it to all parts of the system, no matter how remote from the boiler. It treats every radiator, trap, return line, and all steam operated equipment. Existing scale, oil sludge, rust and other products of corrosion are dissolved into minute particles and held in suspension, flowing off with the condensate. It is claimed to be alkaline and non-caustic and will not injure ferrous or nonferrous metals, packings or gaskets. It neutralizes the acidity caused by oxygen and carbon dioxide, preventing the formation of carbonic acid. Unit is easily installed and is completely automatic. Operates either on 110 or 220 v ac or dc. Pressure-Jet Systems, Inc.

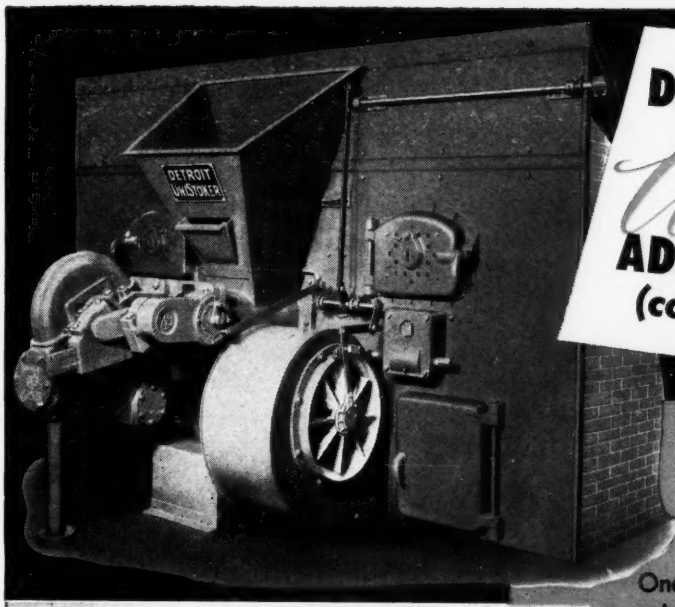


K **Refrigeration Cooling Tower.** Complete line of re-designed Aquatowers is offered to answer the demand for a packaged product up to 50 t of refrigeration. Because the new Aquatower is so compact it is sent out completely assembled, which does away with expensive and uncertain field erection. Features include: All steel integral welded casing with nail-less redwood filling. Completely assembled

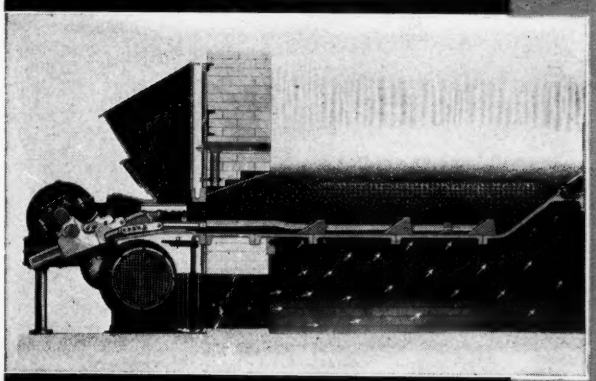


ready for operation as soon as piping and electrical connections are made. Two general styles and seven sizes ranging from 3 to 50 t of refrigeration. All components readily available for servicing. Aluminum fans, all steel basins. Sturdy fan guard insures safe operation. The Marley Co.

L **Extended Surface Radiation.** Type WI extended surface radiation is designed for steam and hot water heating in places where floor or wall space is limited. It is completely non-ferrous, being made up of specially annealed copper tubing, aluminum fins and brass couplings. Tubing is 1⅛ in. od, and 0.035 in. wall thickness. It is good for saturated steam pressures up to 100 psi and temperatures up to 350 F. Fins are made of 0.020 in. aluminum. They are 3 in. square with rounded corners and are rib-reinforced for strength. Standardization is obtained through the use of only one tube dia and one fin size. Units are available in five lengths from 2 to 6 ft. inclusive. Specially de-



DETROIT UNISTOKER *with* DETROIT ADJUSTABLE FEED (coal feed control)



Pays A High Return On Your Investment

Once you install a Detroit UniStoker, you are set for years of *Low Cost* service.

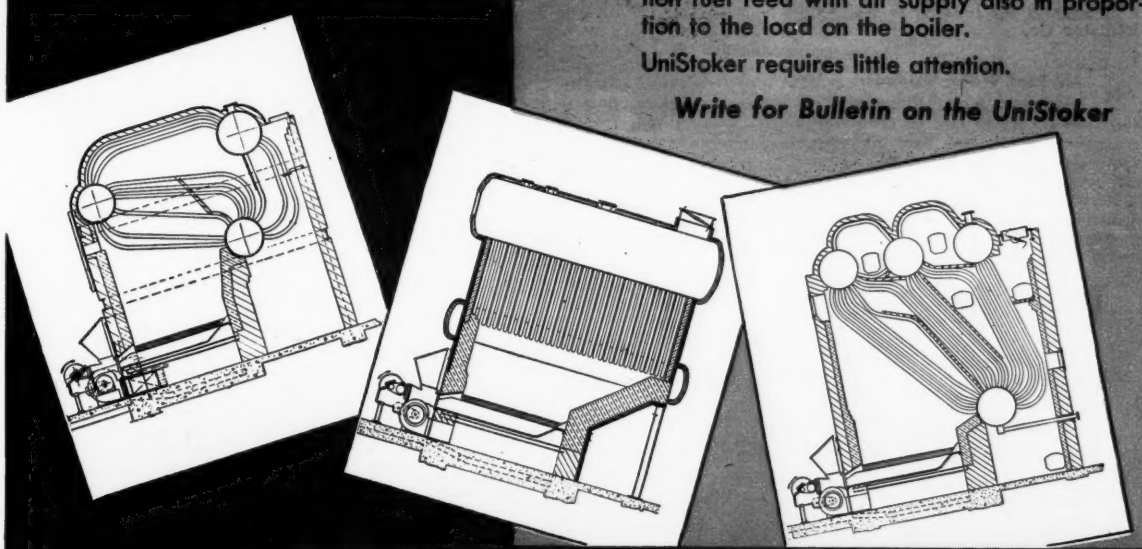
A rugged single retort mechanically driven stoker. Coal is introduced into the retort by heavy plunger. Fuel burned at a low rate per square foot of grate as the stoker has a large active grate area. Side cleaning, ash discharged to ash pit at each side.

Small motor or turbine drive with blower conveniently mounted at stoker front in unit arrangement.

DETROIT ADJUSTABLE FEED OF UNISTOKER—provides both Manual and Automatic regulation fuel feed with air supply also in proportion to the load on the boiler.

UniStoker requires little attention.

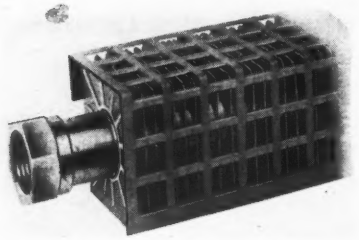
Write for Bulletin on the UniStoker



DETROIT STOKER COMPANY

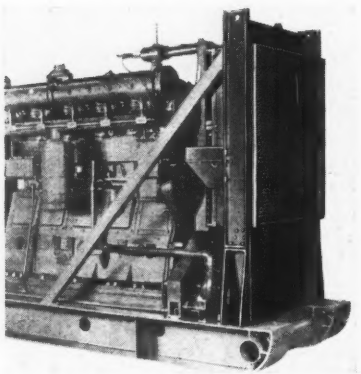
GENERAL MOTORS BUILDING, DETROIT 2, MICHIGAN

WORKS AT MONROE, MICHIGAN • DISTRICT OFFICES IN PRINCIPAL CITIES



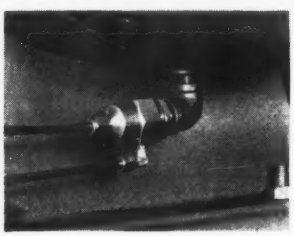
signed brackets, offset adapters and perforated steel covers are also available. Basic rating, based on a single row without cover is 4.25 sq ft e.d.r. or 1,020 Btu per lineal ft with 1 lb steam and 65 F. entering air. Warren Webster & Co.

M **Diesel Radiator.** The new Monoweld welded steel tank and sidemember radiator is a one-piece core construction making possible a lighter,



compact, efficient unit. The unit is one of a complete line ranging in size from 2 ft square, up to 10½ ft sq. Young Radiator Co.

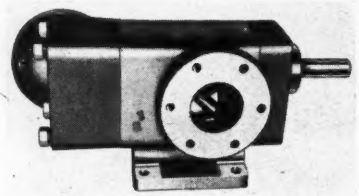
N **Air Tank Water Unloader.** A fully automatic water unloader which removes all water and oil from the air compressor tank has been announced. Designed to fit any electrically operated air compressor which is equipped with a centrifugal or magnetic unloader, the Lansdale water unloader eliminates manual draining of tank by automatically drawing off the harmful water



and oil as it collects. By eliminating this accumulation, the possibility is avoided of its being forced into the air lines thus causing corrosion or clogging of tools or spray mixture. As a means of filtering out particles of rust and dirt and preventing possible damage to the unloading mechanism, the unloader has a wire mesh screen inserted ahead of the mechanism. A. Shelburne Co.

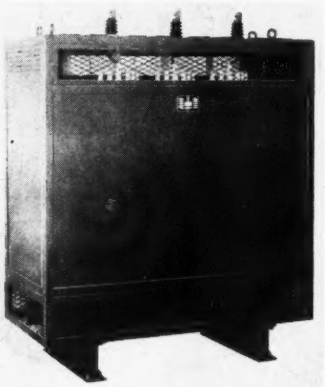
O **Helical Rotor Pumps.** Announced is a line of positive displacement, simple, helical rotor pumps. Two helical rotors, one a driving rotor and the other an idler rotor, force the liquid ahead in an axial flow in volume and at pressure.

The shaft of the driving rotor is mechanically sealed by a shaft seal against leakage. Built in two sizes these pumps are primarily designed for



handling various grades of oils at either 50 or 75 gpm, at pressures of up to 125 psi in a smooth, pulseless flow. Syntron Co.

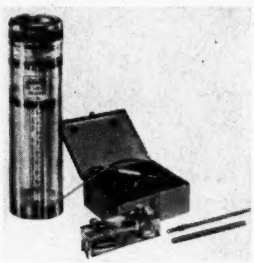
P **Air Cooled Transformer.** Announced is an improved line of dry transformers, designated as Type F. Features include the use of Class B, heatproof insulation, such as air, fibreglass, mica, asbestos, porcelain, etc., and Class C materials. The absence of oil



or liquids renders the unit fire and explosion proof. Because of this type of construction, these transformers can be located at the load center, making long secondary runs unnecessary, thereby effecting further economy.

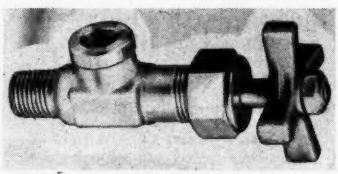
Primary tap switch is standard equipment. Case is constructed to protect transformer element against flooded floor conditions and, at the same time, provides means for the addition of blowers for forced draft in the event future conditions require loading in excess of transformer rating. Available in sizes from 100 to 1000 kva, single or three phase, in voltages to 15,000 v. Marcus Transformer Co., Inc.

Q **Carbon Dioxide Indicator.** A new carbon dioxide indicator, suitable for testing the efficiency of oil burners, furnaces, and other heating plants, has recently been announced. Featuring simplified construction and quick-acting readings, the new instrument is said to afford the highest possible accuracy at moderate cost. The CO_2 indicator is described as being constructed of transparent acrylic material and practically unbreakable, with metal parts of non-corroding stainless steel. Pressure-tight 0 rings developed during the war are used as seals. The



indicator is 8 in. long and 2 in. in dia. Capable of making three tests a minute, the indicator has 4 in. scale that is calibrated to 1/5 of 1 per cent CO_2. Accuracy is stated to be ½ of 1 per cent carbon dioxide. The solution is good for 1000 tests and is easily recharged. F. W. Dwyer Mfg. Co.

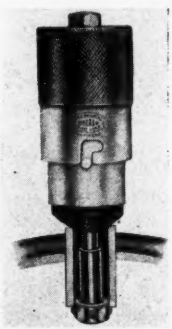
R **Micrometer Needle Valve.** A specially designed needle valve for the sensitive metering of fluids and gases has been developed. The micrometer needle valve has $\frac{5}{16}$ in. 40 stem



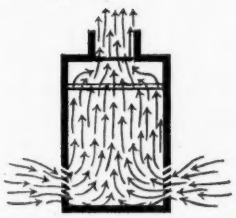
threading for close adjustment, and a long 10 deg included angle tapered needle for fine metering. The standard valve is of high-strength brass, but aluminum alloy bodies can also be supplied. Needle stems are machined to close tolerances in duronze. A premolded packing insure a long-life stem seal.

The valve is available in ⅛ and ¼ in. sizes, with eight port combinations of male and female, pipe and tube connections permitting a variety of installations. Parker Appliance Co.

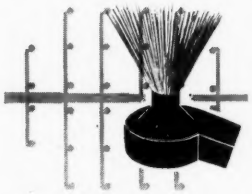
S **Test Plugs and Filling Connectors.** A new line of hydro-matic self-sealing test plugs and pressure line filling connectors equipped with ex-



panding head pull rods, has recently been announced. Employing a unique sealing principle and requiring only a

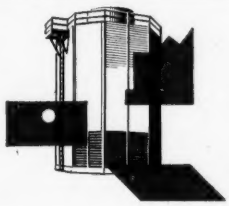


EFFICIENT TOWER DESIGN...



THOROUGH AIR-WATER MIXTURE...

TRUE "COUNTERFLOW"...



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couple of seconds to insert or remove, the plugs and connectors are designed to seal plain or threaded holes in flanged or fitted openings of practically any depth in tanks, boilers and other fabricated or cast vessels which require hydrostatic or air pressure testing. The manufacturer states that the feature is the manner in which testing pressure from within the tank or vessel is utilized to actuate a piston or plunger with sufficient force to hold an effective seal regardless of the actual testing pressure used.

A safety feature and positive holding action is controlled by the bayonet lock in cylinder. This prevents use of plugs or connectors until the expanding heads are properly anchored or engaged against the inside edge of flange or fitting and the plunger is free to be actuated by the internal testing pressure to force and hold the neoprene seal firmly against its seat. The entire pulling force is taken up by a solid stem or pull rod which is securely fastened to a heavy wall in cylinder.

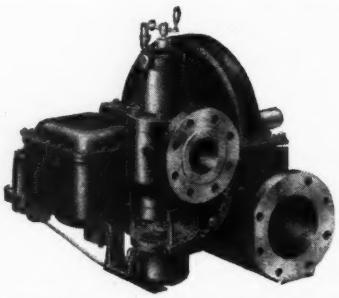
Stock sizes for ¼ to 2 in. pipe openings are available for standard flanges and are suitable for any testing pressure to 500 psi. Interchangeable expanding stems for extra depth flanges and fittings may be had on short notice. The seals may be readily replaced when worn. Mechanical Products Corp.

T Fly-Ash Extractor. Announced is a new device for extracting fly-ash from hot boiler furnaces or chimney bases. Maker claims that the unit will eliminate 90 per cent of the fly-ash leaving building and industrial power chimneys. The unit is said to pick up

and remove the fly-ash from these spots and drop it into disposal units. Fly-ash containing reburnable carbon may be returned to the furnace. Automatic Fly Ash Extractor and Fly Carbon Reburner Systems.

U Mechanical-Drive Turbine. A new small mechanical-drive turbine, designated as Type DP, with ratings from 10 to 1200 hp and with speeds from 1000 to 5000 rpm, has been announced. The Type DP is available in three single-stage frame sizes with a 16, 20, and 25 in. wheel. Embodying such features of large turbines as hydraulic governing for wider speed range and more accurate control, and pressure oiling of bearings to insure positive lubrication, it can be applied as a drive for pumps, compressors, fans, blowers, and similar equipment.

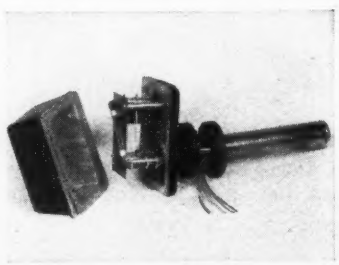
The new oil-relayed governing system gives superior performance over previous mechanical governors. Range of speed adjustment has been increased to 30 per cent; speed regulation has been reduced to 6 per cent. More parts



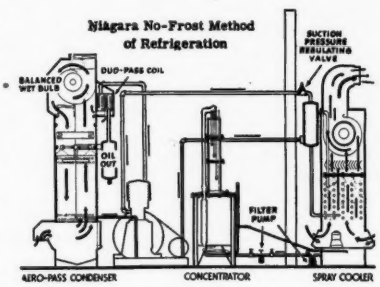
are enclosed, and the governing system is completely encased in an oil atmosphere, thereby eliminating rusting problems on standby service. A new balanced valve design is used for the governing valve and the combined trip-throttle valve. With this design less force is required to operate the valves, and a given size valve can handle larger steam flows. These valves are combined in one assembly. Turbine Div., General Electric Co.

V Transformer Thermal Load Relay. Actuated by a bimetal mounted in a well in the transformer wall in the top oil zone, the new type TRO relay continuously evaluates the hottest-spot temperature of copper windings to operate three snap-action, self-resetting switches. The first switch operates with increase of transformer load to start cooling fans. If load increases and approaches the safe thermal operating limit, the second switch closes to give a warning. If load continues to increase until the thermal limit is reached, the third switch either trips the breaker or gives an alarm.

Action of the transformer relay is dependent upon the temperature of the top oil, the load carried by the transformer, and the length of time the load has been carried. This load-time-temperature characteristic is obtained by placing a heater around the bimetal in the relay, so that the bimetal is responsive to the sum of top oil temperature and a temperature proportional to the heat generated within the transformer coils. Contacts are normally self-resetting. The thermal relay is designed to protect from overloads of the operational type only and will not function on short circuits unless other protective relays have failed to operate. A single relay will protect a three-phase transformer where loads are reasonably well balanced or three single relays can be installed where extreme unbalance is expected. In cases where unbalance between phases is present but less than ten percent, a three-section heater mounted on the TRO relay will protect all three windings of a three-phase transformer against dangerous overloads. TRO relays can be supplied with all new power transformers, or may be used on old transformers by cutting a hole in the tank wall and welding on a boss to accept the relay. Westinghouse Electric Corp.



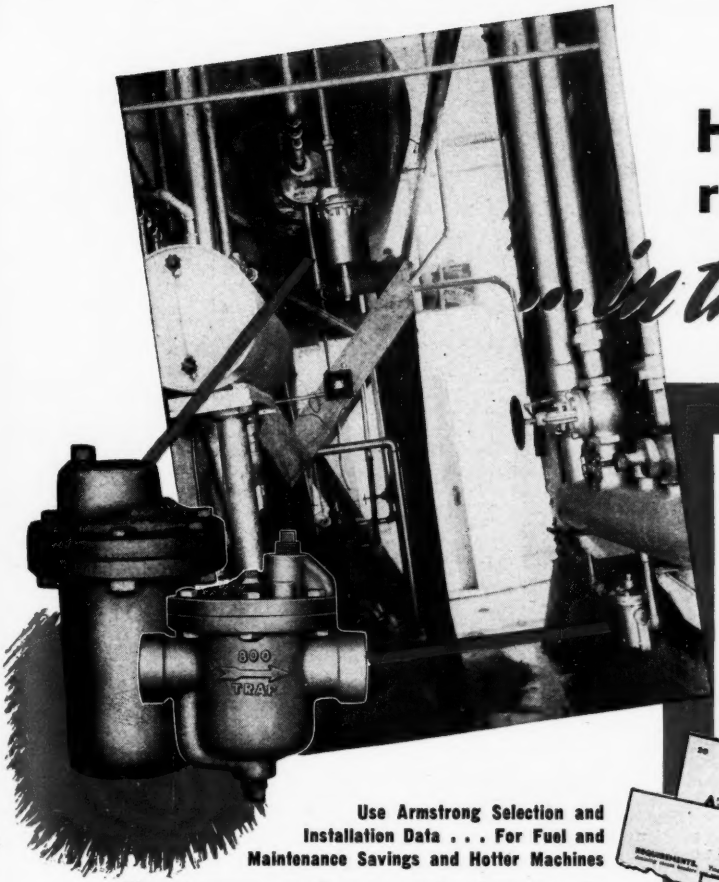
W Refrigeration System. Announced is improved design and construction of apparatus for the No-Frost method of refrigeration for space or products, a system which, because it cools air below the freezing point of water without permitting the formation of frost or ice on refrigerant coils, is especially applicable to chilling or freezing processes which are improved by avoiding interruptions that may impair quality or limit production. It is also applied in air conditioning and in processes where extremely dry air or



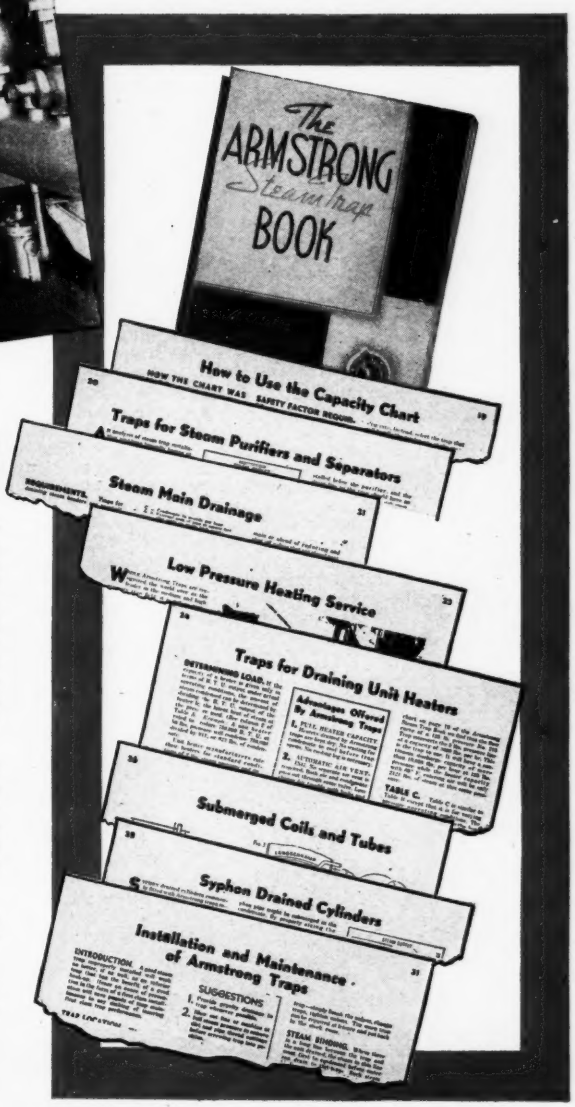
extremely low temperatures are required.

The equipment consists of the fan spray cooler, which chills air and distributes it as required, the concentrator, which maintains the proper concentration of No-Frost liquid, the Aeropass condenser, which condenses the refrigerant gas and controls the head pressure at which the compressor operates, and the compressor, which may be any make selected by the user. These provide a complete refrigeration system that operates with a minimum spread between the suction pressure and head pressure. In the new design a filter in the liquid line removes any dirt or foreign material that the air stream may have picked up and deposited in the liquid, and a metering gear pump is used to insure uniform delivery of the correct amount of liquid to the concentrator regardless of increased pressure resulting from the operation of the filter, and in proper proportion to the amount of condensation taking place in specific cooling or product freezing applications. When the pressure reaches 50 lb the operation is automatically shut down by a pressure switch and a warning light signals the operator to clean the filter. Component units are built in a range of sizes suitable for installations using ten tons of refrigeration and up. Niagara Blower Co.

X Condensate Return Units. Announcement has recently been made of a complete line of condensate return units. These automatic units, recommended for use with steam plants



How to get the right steam trap ... in the right place!


The ARMSTRONG Steam Trap BOOK
How to Use the Capacity Chart
Traps for Steam Purifiers and Separators
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in office buildings, hotels, and industrial establishments using steam process equipment, will handle pressures up to 150 lb and radiation up to 35,000 sq ft. According to the manufacturer, the turbine type pumps furnished with these units provide dependable, quiet operation and handle hot condensate at high pressures without vapor binding or water hammering. The condensate return unit includes a turbine pump, electric motor, strainer, float switch or make-up valve, welded steel receiver, and heavy steel base. This compact unit is manufactured in a number of types, sizes, and models. All models are reported available equipped with two pumps, which provide standby protection or additional capacity if needed. Roy E. Roth Co.

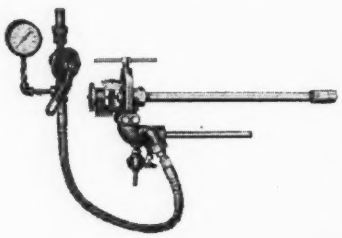
Y **Insulation Calculator.** Available to interested engineers is a pocket insulation calculator for both insulating block and cement. Thickness of insulation required for various cold face and furnace temperatures may be read directly on the calculator. Heat losses in Btu per hr per sq ft through the insulation are also given. The calculator is made of thin plastic, measuring approximately 1½ by 6¼ in. In addition to the insulation data, there are four, 6-in. architects' scales along the edges. The calculator may be had free of charge on request. Forty-Eight Insulations, Inc.

Z **Self-Starting Synchronous Motor.** The precision-built Type SX self-starting synchronous motor has recently been redesigned to make the motor assembly, without gear train, completely self contained. It is designed for use with timing devices, recording and communications equipment, and many other applications requiring constant speed at a given frequency. The motor reaches synchronous speed within ½ to 2 cycles and will stop within one pole of motion on the 240 rpm rotor shaft, ¼ sec, when de-energized. Patented no-back gears determine direction of

rotation so that either clockwise or counterclockwise motors can be supplied to order.

Measuring 2⅜ x 2⅛ x 1½ in., the Type SX produces exceptionally high torque for its size . . . 30 in. oz. at 1 rpm, 60 cycles, for speeds slower than 10 rpm, or 20 in. oz. at 1 rpm, 60 cycles for speeds 10 rpm and faster. Standard gear trains, ranging in speeds from 60 rpm to one revolution in 24 hrs are available, adapting motors to a wide variety of applications. Plastic gears can be substituted for two of the faster rotating metal gears, assuring quiet operation. All shafts are polished to 3 to 5 micro in. A ball thrust bearing against the rotor shaft assures minimum friction. Motor is equipped with friction clutch, permitting turning of drive shaft in either direction independent of gear train and motor. One way friction is available for applications where the driven mechanism must not be turned backwards, yet must be set forward manually. R. W. Cramer Co., Inc.

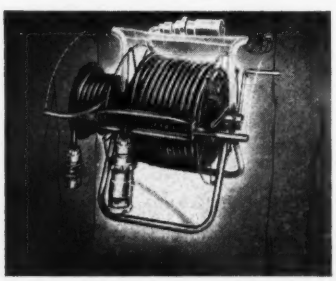
AA **Mechanical Fuel Atomizer.** A new mechanical fuel oil atomizer which has a wide range and eliminates the necessity of changing sprayer plates is now in production by The Engineer



Company, manufacturers of combustion equipment for liquid and gaseous fuels. The new atomizer has a capacity range of 10 to 1 without returning or recirculating oil which, is delivered to the atomizer at 300 psi.

Variation of output is obtained within the atomizer by manual or automatic adjustment of a hand wheel. This eliminates cutting burners in and out of service to control load range. Use of this constant oil pressure produces uniform atomization over the entire load range. Greater load ranges are possible with higher oil pressures. Because the design of the wide range atomizer is simple, cleaning of sprayer plates is virtually eliminated, and loss of efficiency due to carbonization of tips is substantially reduced. The new device has been used successfully with many types of air registers on steam generators and with gas turbines, and is finding increasing use in many other fields. Engineer Co.

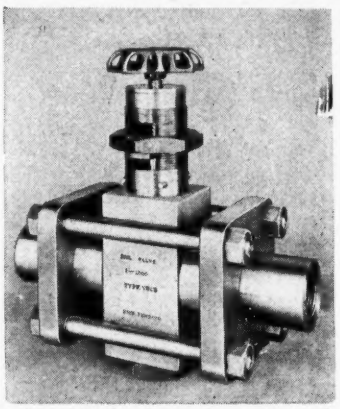
BB **Power Cable Reel.** Called the Powereel, this new device is a portable reel designed to house up to 300 ft of ¾ in. No. 12, four-conductor cable or equivalent. Twin handles of the combination handle and cord guide make two-man carrying of heavy cable easy work. A special feature of the frame is the use of the tubular steel supports as sled runners to facilitate passing the reel in and out of trucks. Since the runners are at right angles to the direction of rotation of the reel, it has no tendency to slip as the cable



is unwound. Designed for use with any phase current, the reel comes standard with 3 or 4 collector rings. The rings are of heavy beryilium copper with double copper contact brushes, and are seated in a phenolic casting, housed in metal. The Powereel is rated 75 amps at 220 v.

Without cable and plugs, the reel weighs 21 lb for the standard models. Attractive features of the reel include an adjustable brake and lock to control free-rotation and eliminate overwinding . . . ability to adjust the reel-flanges to give wide-diameter winding in the case of short cable lengths . . . and free-running crank handle grip to make re-winding easy. Industrial Electrical Works.

CC **Blow-Down Valve.** Based on the new Paul venturi ball valve principle, the new Paul continuous blow-down valve is said to be ideal for rigorous continuous boiler blow-down service. With only two moving parts and no springs, the new Paul Valve utilizes the Bernoulli theorem to force a precision ball into the low-pressure center of the stream, and hence into the seat. The body of the valve is



machined to the shape of a venturi tube.

Hard Stellite inlet and outlet bushings, incorporating the seats, and a hard Stellite ball make the parts subject to the greatest wear as resistant as possible. Other valve parts are supplied in high chromium stainless steel. The valve is of the outside screw and yoke type so that the stem threads are not exposed to excessive heat and reaction of the fluid. The retainers with the inlet and outlet connections are held by outside bolts; thus, without breaking the pipe connections, the valve may be opened to inspect, renew or repair the interior parts. The packing gland is ample and an outside nut, bearing against the follower, is readily accessible for tightening. To remove and inspect the ball or to examine the conditions of the seats, it is only necessary to take out the bottom body plug.

Type VBCB, 1500 lb series are available in sizes from ¼ to 1 in., conforming with inside dimensions of Schedule 80 pipe. When installing the valve in lines of other types of pipe, the nominal size of the valve should correspond with the inside diameter of the pipe so that the valve will not be oversized and will operate at or near the wide-open position to minimize wear. Screwed ends are standard; socket or butt welding ends optional. Paul Valve Corporation.

FLOWMATICS

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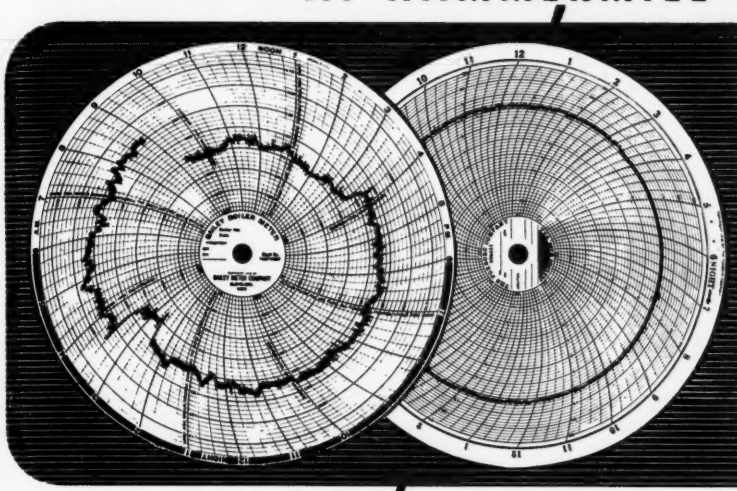

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Combustion Engineering Type VU

MAXIMUM RATING
150,000 pounds per hour

STEAM CONDITIONS
675 psi and 775 degrees F. at the superheater outlet

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Averages 54 percent

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COPES Flowmatic Type R-O

Hold BOILER WATER LEVEL WITHIN *Plus* OR *Minus* 1/2 INCH!

Except for momentary shrink and swell on sudden changes in boiler load, COPES Flowmatic is holding water level within plus-or-minus one-half inch on the two new Combustion Engineering Type VU Steam Generators at Hammermill Paper Company. Such close control is desirable for any fast-steaming boiler—especially if loads fluctuate rapidly or widely. You can be sure of this safe level control if you insist on the modern two-element COPES Flowmatic Regulator.

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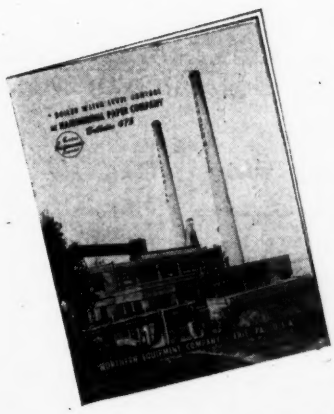

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READING TIME: 35 SECONDS

Not once-upon-a-time, but *today*, there is a certain valve that is giving such outstanding satisfaction in boiler blow-down service, that more than four out of every five high pressure boiler plants in the United States use it. That blow-off valve is the Yarway.

The reasons are threefold—excellent design, sound engineering, careful manufacture.

Yarway's famous Seatless Valves have no seat to score, wear, clog and leak. And Yarway Hard Seat Valves, especially suited for high pressure service, have special stellited seats and discs.

Second, constant research, leading to mechanical and metallurgical advancements keeps Yarway Valves ahead of changing service requirements.

Lastly, forty years of making blow-off valves, has taught Yarway how to make them right.

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A SYMBOL OF QUALITY AND SOUND ENGINEERING

YARWAY BLOW-OFF VALVES

WHAT LEADERS SAY

Power Engineer's Future Is Bright

By A. C. MONTEITH

TODAY there are many opportunities in the electric power industry. In examining them, the young engineer must not permit the glamor of some fields to blind him to the possibilities in the stable and time-tried fields. The past performance of these tried fields is well known and the future is, therefore, more predictable. The real problem is to be able to recognize the long term opportunities.

Today, the young graduating engineer is not generally interested in the power field. In recruiting, we find two students interested in electronics and communications to every one interested in power. I am not going into the reasons why this ratio exists, but rather suggest a selling program to restore better balance. In Westinghouse, the demand for power as compared to electronics men is about 10:1, which is probably typical of a manufacturing company whose major interest is in the power field and is probably low for a power generating company.

All industries are expanding rapidly and many new industries are mushrooming up over night, but power is the key to all. The chemical, steel, paper, petroleum, and coal are a few of the better known industries that have been and are still experiencing growth. The electrical industry is, however, becoming more and more the key to the expansion programs of this country.

Each year more electricity is used per unit of product. Also, the use of labor saving devices is increasing. In the year 1900, there were installed in this country about 2 hp per worker. Today, there is 7.25 hp per worker and there are many more workers. There is also a greater percentage of electrical power as compared to mechanical power now and this percentage is increasing. In other words, electricity is becoming the slave of American industry or the basis for the American way of life, which is founded on production. If we accept the conservative estimate that a 1-hp motor will do the work of 50 men, the number of slaves backing the American worker has increased from 100 in 1900 to 375 today.

Some might feel that we are in boom times and that the use of power would rise and fall much the same as our national production. But in the recession of 1921, our national production fell off 18 per cent from its previous high, while the use of electricity fell off only 9 per cent. Furthermore, kilowatt hour use established a new record in just one year, whereas national production did not reach a new high peak until 1925.

In the depression of the 30's, while our gross national production fell 45 per cent below the 1929 peak, use of electricity fell off only 15 per cent. A new peak in use of electrical energy was established by 1935 but our gross national production did not reach a new high until 1941. Thus, although depressions affect the use of electrical energy, so far they have represented mere hesitations in the parade.

To date, 52,000,000 kw in generating capacity have been installed to serve the public in the United States. W. J. Herrman of the Commonwealth & Southern Corp. and E. L. Lindseth of the Cleveland Electric Illuminating Co. have presented some curves based on records of past performance. They predict an installed capacity of 92,000,000 kw in 1957 and 250,000,000 kw in 1977. In other words, an average of 4,000,000 kw of capacity a year installed over the next 10 years. There is being installed or is on order generating equipment sufficient to meet a rate of over 5,000,000 kw a year for at least the next three years.

When we analyze the factors contributing to this continued increase in the use of electricity, there are two broad classifications to consider, namely, luxury or convenience power and productive power. A survey made during the war indicated that there were 100,000 factories, 1,000,000 offices, 1,200,000 stores, 300,000 eating places, and 250,000 gas stations all ready to improve their lighting. The introduction of fluorescent lights has given an added impetus to revamping all lighting. In revamping the lighting systems, however, people will not be satisfied with twice the intensity. They will want six to ten times, with the resultant increase of three to five times the use of power.

An expansion of street lighting is expected. The War gave a real opportunity to secure statistics on the influence of this on the protection of life. Good street lighting saves lives.

Where there was a potential market of 2500 kwhr in the home in 1920, there is a potential market of over 10,000 kwhr in the modern home. New laundry equipment, electric driers, air conditioning and cleaning, cooking and water heating, and the many new types of appliances all contribute to this increase in potential.

The average domestic consumer now uses 1400 kwhr per year. Estimates are made that this will double in 10 years and some companies believe that when the right time comes, a good selling job will accelerate this growth.

Let us look at an example of a new industrial load. The introduc-

(Continued on page 127)

Alexander C. Monteith is Manager of Headquarters Engineering for Westinghouse Electric Corp., responsible for engineering laboratories and standards, engineering dealings with industry, engineering contacts with foreign licensees, and engineering association contacts. He is also Director of Education, responsible for student recruitment and training and university relations. Mr. Monteith was born in Brucefield, Ontario, Canada, in 1902. He was graduated from Queens University, Kingston, Ontario, in 1923 with a B.S. degree in electrical engineering. In college he won the Governor-General's medal. He joined the Westinghouse Co. as a graduate student engineer immediately after graduation and the following year entered the Central Station Engineering Department at the East Pittsburgh Works. He was named manager of the department in 1938, was chosen manager of the Industry Engineering Department in April of 1941 and was appointed to his present positions in 1946.

Mr. Monteith has for many years played a leading role in the activities of AIEE; he has been chairman and vice chairman of several of the Institute's national committees, including its important Standards Committee. He is also a member of ASME, the Engineer's Society of Western Pennsylvania, ASEE, and is technical advisor on the International Electro-technical Commission and active in ASA and NEMA. Mr. Monteith holds the Westinghouse Order of Merit. The above is from his paper before the 1948 Midwest Power Conference in Chicago.

New Ideas in Control Board Lighting

By FRANK P. KUHL

Here are some new and practical ideas for giving power plant operators the "seeing" comfort they need for most efficient work in operation of their plants. These ideas have been carried out in the central control room for Boilers 11 and 12 at Hell Gate Station of Consolidated Edison Co. of New York, Inc. Whatever the arrangement, either for boiler and turbine control or for electrical switchboards, the author hopes these data will suggest ways in which other engineers may adapt the ideas to their particular conditions.

This article is one of the Merit Award Winning entries in the 2nd International Lighting Exposition and Conference; and this is the first, exclusive publication of it. Its author, Frank P. Kuhl, is chief draftsman of the Consolidated Edison Co. of New York, Inc., covering generating plant and substation design. He is a licensed professional engineer, member of AIEE, has been active on ASA, AIEE, EEI and AEIC committees.

He is inventor of the patented cylindrical louvered indirect lighting fixture employing the silvered bowl incandescent lamp and was responsible for the installation utilizing them that won the Augustus D. Curtis Award for 1939-40.

THE LIGHTING INSTALLATION described here is novel in that rather than following any general pattern for the illumination of large control board installations, it provides some new patterns. Sufficient data are presented herewith to enable others so inclined to apply to their own problems such features as may seem desirable to them.

The installation was made in the control room for Boilers 11 and 12 at the Hell Gate generating station of the Consolidated Edison Co. of New York, Inc., located at 134th St and Locust Ave., New York City. It was completed in February of 1946 and is shown in Figs. 1 and 3, which were taken just before completion.

The requirements were to provide illumination in a windowless room, 22 ft 2 in wide by 23 ft 6 in long, housing a number of control boards, and to co-ordinate the internal lighting of the instruments wherever necessary and practical in order to obtain a comfortable visual condition for the operating personnel, who work on a three-shift 24-hr basis. The operator's position may be either in front of the bench or between the bench and the vertical board looking in either direction. A cross section of the room is shown in Fig. 2.

Fixtures used in this installation were custom built by H H Roberts & Co., Inc., The 30-watt T-8 lamp was used because its small diameter of 1 in. allowed for the design of mini-

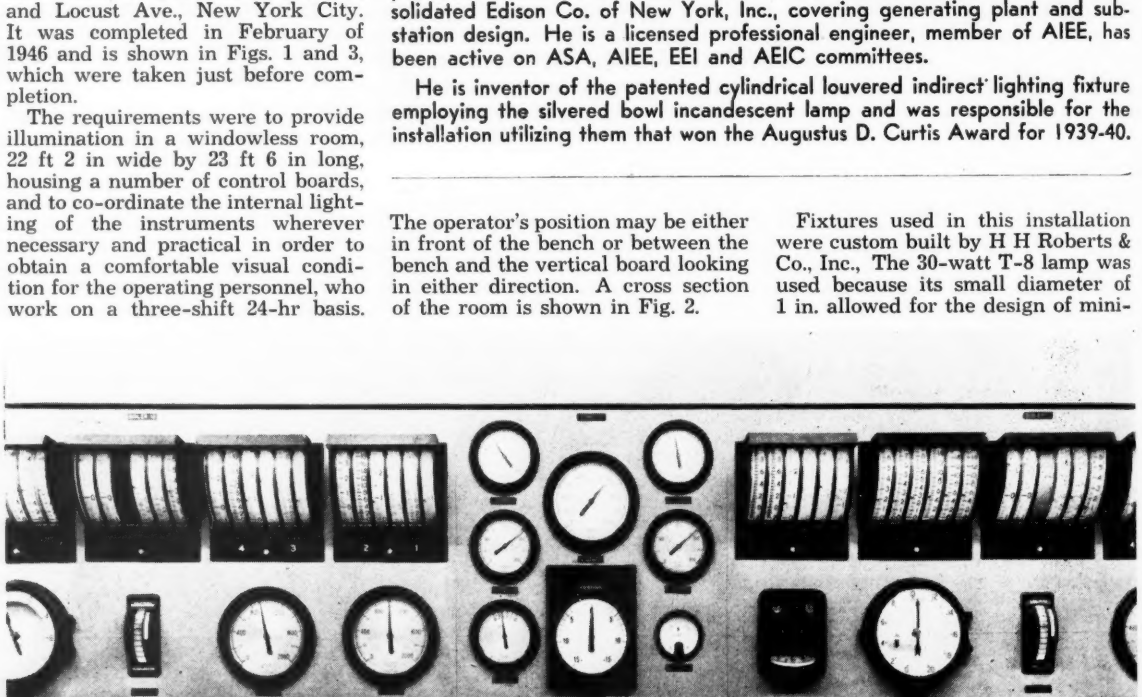


Fig. 1. View of main control board for Boilers 11 and 12, Hell Gate Station, as the operator sees it from his position directly in front of the bench. This view shows illumination provided by the methods shown in article

mum sized reflectors, and 100-watt T-17 lamps were used where the size of the reflector is concealed.

Factors Affecting Control Board Lighting

Lighting of control boards has been a complicated problem, because instruments may lie in both horizontal and vertical planes or at an angle to either; and, in some instances, they have convex glass faces. All of these conditions had to be contended with in this installation.

Study of existing installations employing direct and indirect systems disclosed a number of inherent faults. Use of indirect lighting as the principal illuminating source presents a large area of ceiling brightness, which is usually reflected by some of the instruments in both the horizontal and vertical planes. Use of direct lighting, employing incandescent lamps and prismatic distribution lenses for the vertical boards, requires that these units be mounted quite close to the boards in order that the angle of incidence be such as to avoid any reflection that would be visible to the operator.

When employing a canopy and prismatic lens covered light sources, such as are commonly employed for lighting control boards, it is impossible to obtain a condition in which the operator is free from both specular and mirrored reflections of the light source in the glass faces of the instruments, unless the operator is limited to positions where his eyes are not within the critical angle of reflection.

Placing the direct lighting source in the ceiling, without some general illumination thereon, results in too great a contrast between the lighted and unlighted areas, thereby causing eye discomfort.

The contrast could be reduced by employing a light-colored floor that would reflect the light back to the ceiling; but this is impractical in a power plant due to the constant tracking of coal dust and oil. A dark ceiling creates a feeling of oppresion and confinement and is therefore depressing to the occupants of the room.

Three Light Sources Co-ordinated

The foregoing observations led to the conclusion that ceilings that are brightly lighted or have strongly contrasting areas should be avoided to reduce mirrored reflections in the glass faces of instruments, and led to the co-ordinated design, shown in Fig. 2, consisting of three types of lighting sources:

1. Specific cove lighting
2. Specific trough lighting
3. General indirect lighting

The systems were set up experimentally. The results of each type and the combination of the three are shown in Fig. 5., photographs E1 to E5 inclusive. Additional combinations in the final installation are shown on Fig. 6.

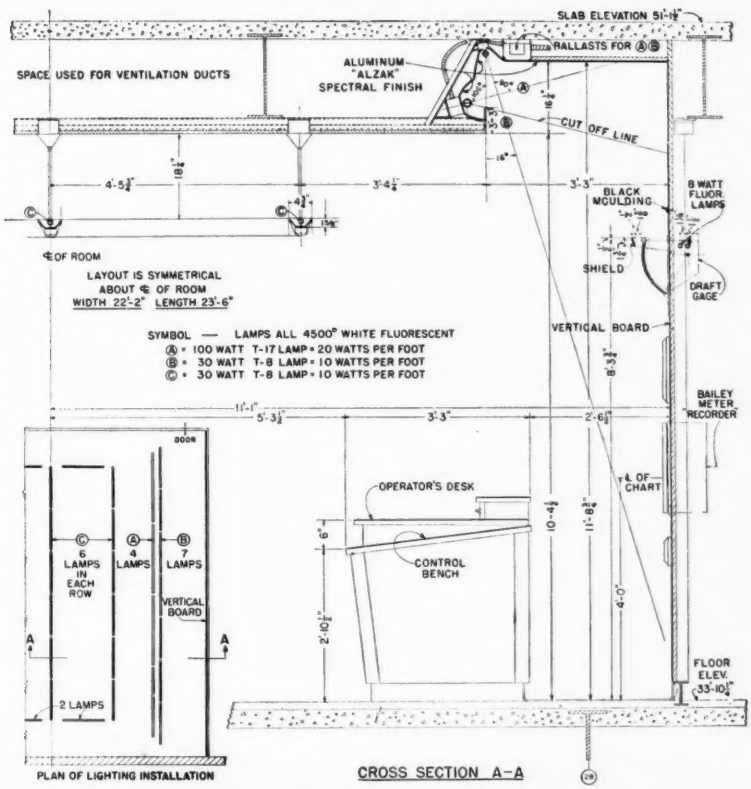


Fig. 2. Plan and cross-section of control room, Boilers 11 and 12, Hell Gate, showing how four lighting sources were installed and co-ordinated: (A)—Indirect cove illumination; (B) Direct trough illumination; (C)—Indirect room illumination; instrument internal lighting. See Fig. 4 for illumination intensities and brightness readings

Different Light Combinations

Photograph E1, Fig. 5 shows the high degree of brightness contrast resulting from purely *internal instrument lighting.*

Reflection of the ceiling on the convex surface of the draft gage, when a totally *indirect lighting* source is employed, is shown in E2,

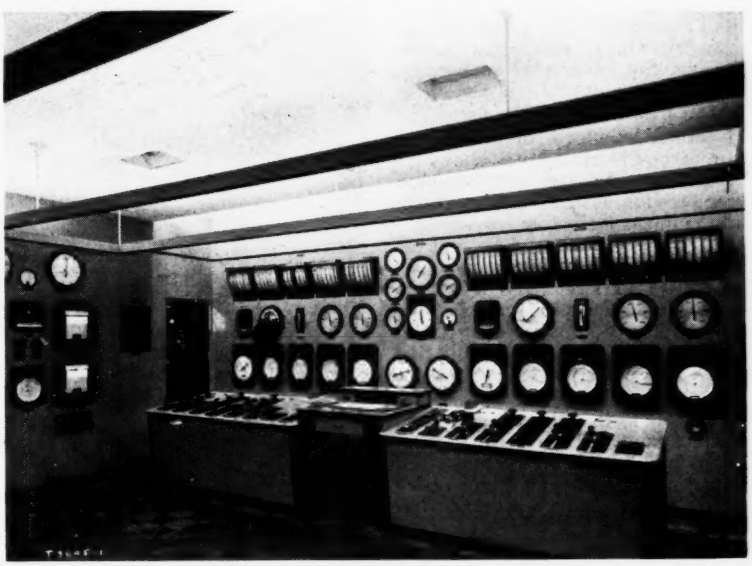


Fig. 3. General view of entire control room for Boilers 11 and 12, Hell Gate Station. Room is entirely enclosed, with no daylight illumination. Troughs for indirect room illumination (C) overhead. Indirect cove and direct trough illumination in recess in ceiling as in Fig. 2

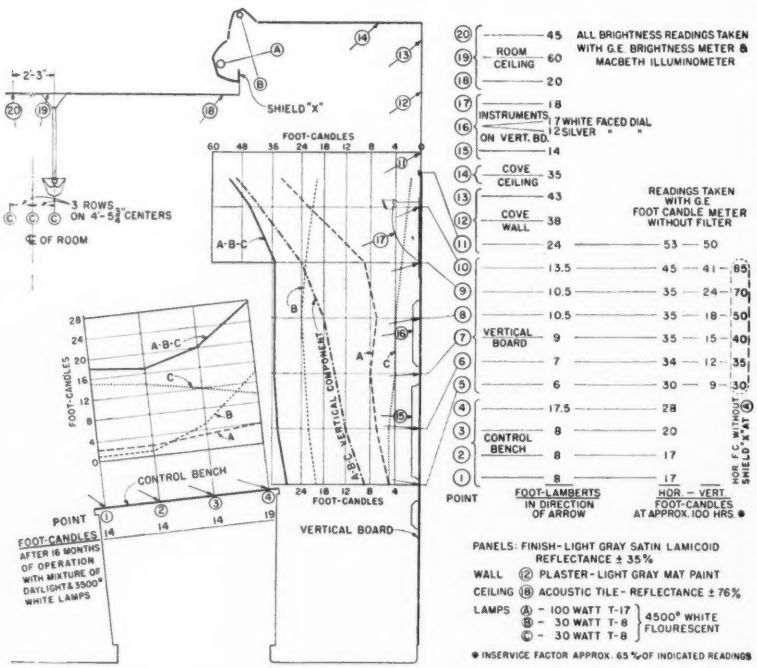

SHIELD "X"
FOOT-CANDLES
3 ROWS ON 4'-5¾" CENTERS
℄ OF ROOM
A-B-C
CONTROL BENCH
VERTICAL BOARD
FOOT-CANDLES AFTER 16 MONTHS OF OPERATION WITH MIXTURE OF DAYLIGHT & 3500° WHITE LAMPS
ROOM CEILING
INSTRUMENTS ON VERT. BD.
COVE CEILING
COVE WALL
VERTICAL BOARD
CONTROL BENCH
ALL BRIGHTNESS READINGS TAKEN WITH G.E. BRIGHTNESS METER & MACBETH ILLUMINOMETER
7 WHITE FACED DIAL
12 SILVER
READINGS TAKEN WITH G.E. FOOT CANDLE METER WITHOUT FILTER
HOR. F.C. WITHOUT SHIELD "X" AT ⑭
POINT
FOOT-LAMBERTS IN DIRECTION OF ARROW
HOR. – VERT. FOOT-CANDLES AT APPROX. 100 HRS. *
PANELS: FINISH - LIGHT GRAY SATIN LAMICOID REFLECTANCE ± 35%
WALL ⑫ PLASTER - LIGHT GRAY MAT PAINT
CEILING ⑱ ACOUSTIC TILE - REFLECTANCE ± 76%
LAMPS Ⓐ - 100 WATT T-17
Ⓑ - 30 WATT T-8
Ⓒ - 30 WATT T-8
4500° WHITE FLOURESCENT
* INSERVICE FACTOR APPROX. 65 % OF INDICATED READINGS

Fig. 4. Section through control room showing illumination intensities and brightness values for physical arrangement shown in Fig. 2

Fig. 5. This reflection seriously impairs the reading of the draft gage scales. This system supplies the major component of light falling on the control bench.

Results of *indirect cove lighting* are shown in E3, Fig. 5. Here the draft gage scales are quite readable. There is insufficient punch to reach the lower portions of the vertical board, but some illumination is contributed to the control bench.

Effect of *direct trough lighting* is shown in E4, Fig. 5, resulting in good illumination on the upper portion of the board, but rather harsh shadows on the lower portion because of the small vertical component of light reaching that surface.

Combined effect of all three sources of illumination is shown in E5, Fig. 5. The indirect cove and direct trough systems tend to wash out the image picked up from the indirectly lighted ceiling. The indirect ceiling system softens the shadows created by the direct trough system, and the indirect cove system lights the upper portion of the vertical board and also spreads illumination on the horizontal surface of the control bench.

In the final installation, each row of lamps is provided with switching. This is highly desirable because the control board is in continuous operation. It allows the operators, who change shift every 8 hr, to obtain any combination desirable to meet their individual requirements. The results of these combinations are shown in Fig. 6.

In addition to the external illumination, instruments were equipped, wherever possible, with internal fluorescent light sources by the manufacturers, in order to provide the proper brightness ratio between the instruments and the adjacent panel surface. In some instances, modification was necessary to obtain the desired distribution of brightness. An additional lamp was installed in each draft gage, resulting in a brightness of 18 foot-Lamberts,[1] in comparison with 10.5 for the adjacent panel surface. This practically washes out reflection of ceiling image. In addition, a shield was installed to block external light reflection on the upper portion of the convex glass of these gages.

Lighting in the recorders was redesigned by shifting the lamp to an almost horizontal position and equipping it with a reflector. A second reflector was installed extending downward from both ends of the lamp and around the lower perimeter of the chart. This reflects light back to the chart, resulting in a relatively even surface brightness on the chart of 14 foot-Lamberts, as compared with 7 for the adjacent panel surface.

Figure 4 contains a tabulation of

[1] The foot-Lambert is a unit of surface brightness used in light measurements. 1 foot-Lambert = 1 foot-Candle × Reflection factor of Surface. 1 foot-Candle is the illumination at a point on a surface that is one foot from and perpendicular to a uniform point source of one candle.

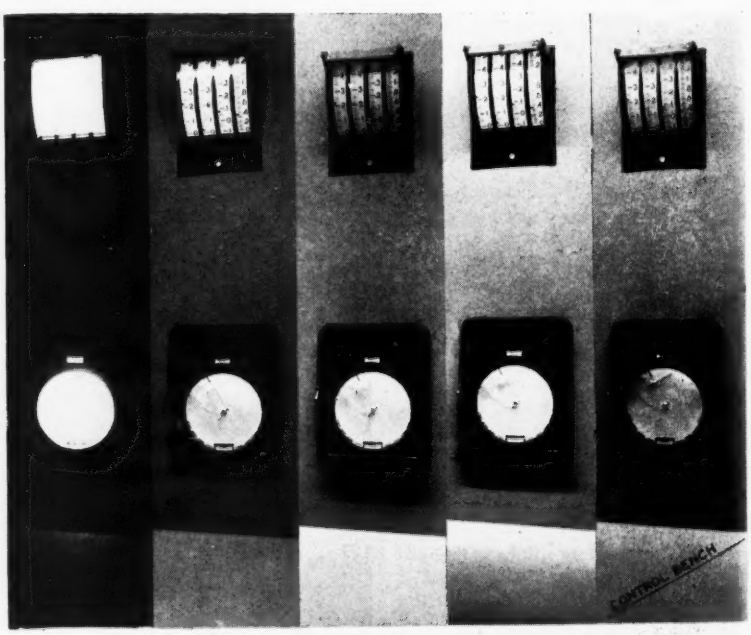


Fig. 5. Views of an experimental set-up used to measure results of various combinations of lighting provided by Fig. 2

E-1—Instrument Internal illumination only
E-2 (C)—30 watt indirect room illumination plus instrument internal lighting
E-3 (A)—100-watt indirect cove illumination plus instrument internal lighting
E-4 (B)—30-watt direct trough illumination plus instrument internal lighting
E-5 (A) (B) (C) all illumination

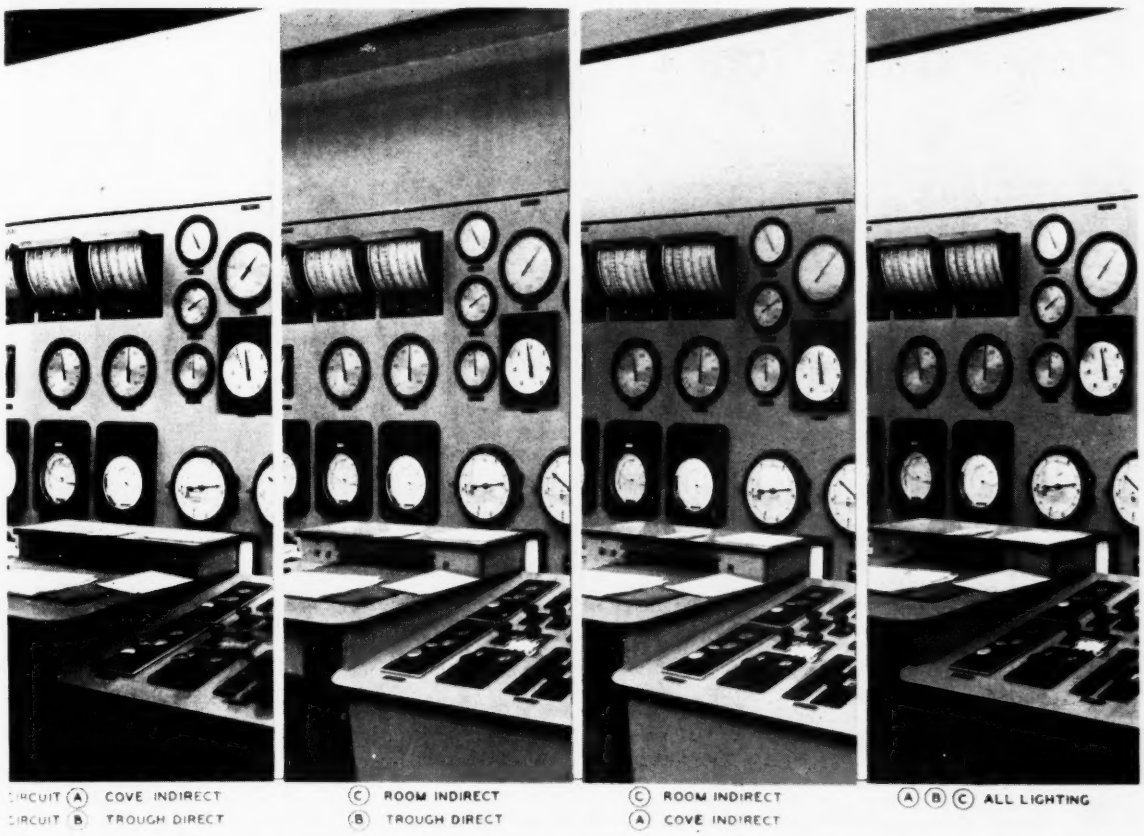


Fig. 6. Lighting effects on actual control board of Fig. 1 resulting from different circuit combinations available by switching. All these pictures were timed alike in exposure, developing and printing

foot-candle and foot-Lambert readings for the completed installation. These readings were taken 16 months after the installation was completed, and 100 hr after the old lamps had been replaced. Before relamping, the reflectors and old lamps were wiped clean of coal dust. However, a thin film of oil remained on all surfaces.

Light Readings and Results

Readings taken at Points 1, 2, 3, and 4 of Fig. 4 were 14, 14, 14, and 19 foot-candles respectively. The ratio between these readings and the values for the same points given in the tabulation will give in-service values for all other tabulated points. Brightness throughout the normal visual range of the operator on the control board runs between 6 and 24 foot-Lamberts.

The upper limit of the operator's visual range on the vertical control board is affected by a thin black line consisting of 1 in. by ⅛ in. moulding strip located immediately above the draft gages, as shown on Figs. 1, 3 and 6. It acts subconsciously on the operator as an effective barrier to the area just above it, which has a maximum brightness of 43 foot-Lamberts. The comparative horizontal component in foot-candles for the normal visual range runs from 30 to 53 foot-candles and the vertical component from 9 to 50 foot-candles.

Further improvement may be realized by slightly changing the angular position of (A) (the indirect cove lighting, Figs. 2 and 4) thereby developing a greater down-punch and, incidentally, reducing the brightness values at points 12 and 13. It may also be effected by the redesign of (C) (the indirect room illumination, Figs. 2 and 4) supplying the greatest component of illumination falling on the control bench so that the brightness value at point 19 is leveled off, thereby reducing the intensity of the ceiling image pick-up by the convex glass surface of the draft gages on the vertical board.

In conclusion, it may be stated that after 16 months of service the usual criticism of a new application seems to be lacking and the installation has provided comfortable seeing conditions for the operating personnel.

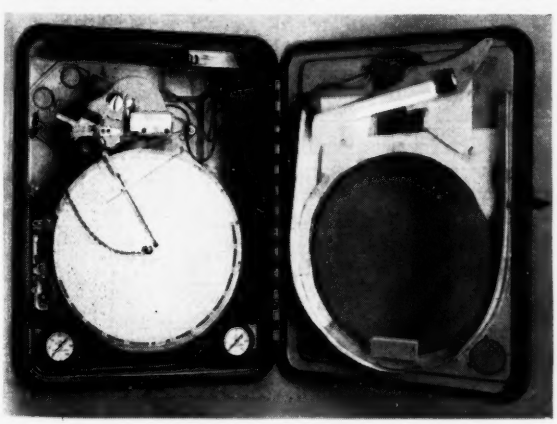


Fig. 7. Close-up of one of the recorders, with internal lighting redesigned to shift lamp almost horizontal and installation of reflector around chart to reflect light back onto chart. This produces even surface brightness of 14 foot-Lamberts on the chart, compared to 7 on adjacent panel

[2] All photographs were taken without the aid of any additional lighting sources. Because of shortages existing at the time the pictures were taken, fixtures were equipped with a mixture of daylight and 3500-deg fluorescent lamps, which may be apparent on close observation.

How Power from Process Steam Will Pay at Roebling's

Installation of 5000-kw, 650-psi, 750-F turbine generator to supply extraction steam at 150 psi 390 F, to processes at plant of John A. Roebling's Sons Co. . . . Will generate from 30% to 50% of total electric power required at fuel cost of $0.0017 per kwhr, with purchased power costs $0.0087 per kwhr for the remainder; turbine also supplies large proportion of process steam required at 150 psi, 390 F . . . Fuel cost $0.30 per million Btu . . . Saving equals approximately 25% of initial investment . . . Details of method of calculating comparative power costs, also amount generated in supplying process steam

By **WILLIAM E. ZELLEY** Superintendent of Maintenance & Utilities, John A. Roebling's Sons Co., Roebling, N. J.

WE HAVE JUST passed through a period of several years that have seen the expenditure of vast quantities of our natural resources, one of the most important of which is fuel. During that time and continuing after the successful termination of the war, the quantity of electrical power required by the industries of this country has increased by leaps and bounds, and many of the public utility systems in this country have found themselves unable to take on additional loads because their plant expansion had not kept pace with the demand increase.

The power available per employee, according to a recent survey, was approximately 6.3 hp, in 1939; but in 1947 when normally we would expect an increase in this figure, the available power per employee has dropped to 4.6 hp, a drop of 33⅓ per cent.

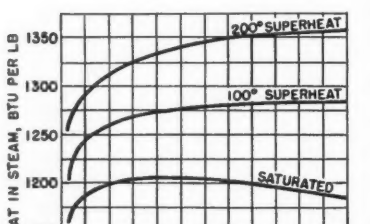


Fig. 1. Comparison of useful heat in steam at various pressures and temperatures

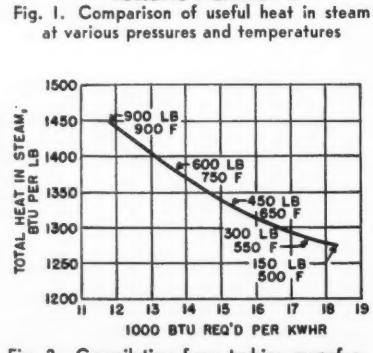


Fig. 2. Compilation from turbine manufacturers data of Btu required to produce a kilowatt-hour at various initial conditions

At the same time, many of the industrial plants purchasing power from the utility companies were using the products of their fuels inefficiently and could, by having a workable agreement with the utility, generate at a lower cost a portion of their power requirement.

This would result in: 1. Lowered cost of power; 2. Reduction of the demand on the capacity of the public utility systems; 3. Making the plants less vulnerable to loss of power in the event of transmission line faults.

This paper is not now, nor ever was, intended to advise any industrial user of power to enter the field of power generation in competition with the established public utility system serving his particular area. The valuable service the utilities have rendered during the past years, and the continued decrease in the cost of electrical power to the consumer, have demonstrated that they are an important cog in this machine of industrial progress and good living.

However, a field that is now being explored in greater detail than in years past, and that offers a substantial saving in the cost of power for the industrial plant, is the use of extraction or topping turbine generators where a sufficient quantity of relatively low-pressure steam is required for general process use and for heating.

How Study of Process Steam and Electricity Was Made

We were recently assigned to study a plant, located in New Jersey, that had been generating steam for industrial power and heating at 150 psig with little or no superheating of the steam. The old steam-generating equipment was very inefficient and beyond economical repair; and it soon became apparent that it was necessary to make a complete replacement of the steam generating equipment. Accordingly, the steam requirements of the plant were carefully studied, and the size and number of new boilers were determined. Details of this study and its results, given below, were presented by the author in a paper, Economics of Process Steam Generation, before the annual AIEE meeting at Pittsburgh, January 1948.

Final selection of operating pressure and temperature was not made until a thorough survey of the electrical power requirements had been completed. That survey indicated that a large portion of the electrical

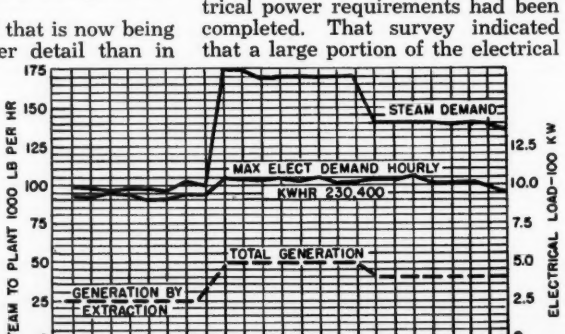


Fig. 3 Demand for 150-psi steam and electric power for a typical 24-hr day at plant of John A. Roebling's Sons Co.

power could be economically generated by the use of an extraction turbine generator, so it was decided that this plant could be most economically served by the installation of boilers capable of producing the required amount of steam at 650 psi and total steam temperature of 750 F.

In order to make a complete survey of the possibilities of generating power in this plant, a careful compilation of the electrical loads for the past several years was made, and a day-by-day plotting of steam demands at 150 psig was made and compared with the electrical demands.

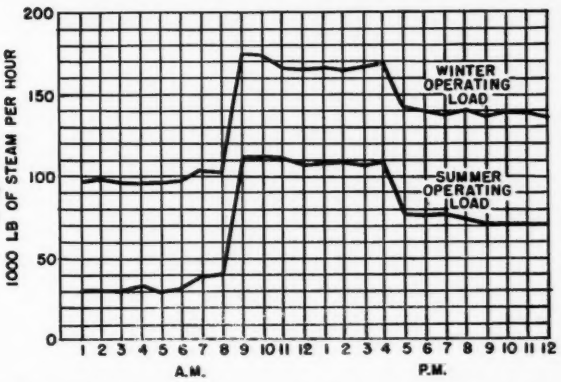


Fig. 4. Representative 24-hr steam load for both summer and winter operation, plant of John A. Roebling's Sons Co.

5000-kw Unit Gives Maximum Return

This survey indicated that by the installation of a 5000-kw turbine generator, we could generate 30 per cent of the power required by the plant during the year, with some variation between the summer and winter seasons. By adding a condenser to this unit, it was possible to increase this percentage of power to be generated to 50 per cent. This was possible with no increase in operating labor, and even though the fuel rate per kilowatt-hour is increased, the cost per kilowatt-hour is still well below that of purchased power.

By actually calculating the power that could be generated under all conditions by the use of several sizes of generators—3000, 4000, 5000 and 6000 kw—the 5000-kw unit was selected as the one that would allow maximum return on the investment.

Demand for steam at 150 psi and electrical power during the 24-hr day is shown in Fig. 3. Electrical demand at all times is a greater percentage of maximum than the steam demand, a very favorable condition for the operation of the extraction type turbine generator; for it will always be possible to consume all the power that may be generated by reducing in the turbine the pressure and temperature of the steam required by the plant from 650 psi, 750 F to 150 psi, 390 F.

The steam requirements show some variation between the winter and summer condition, Fig. 4, and under certain conditions it may not be possible at all times to pass the total steam required through the turbine so a pressure reducing and desuperheating station has been installed to supply the excess low-pressure steam required. Schematic arrangement of the steam piping and equipment is shown on Fig. 6, also the proportion of steam to be passed through each path under normal conditions.

Because of some rather extreme operating conditions, and some more or less indefinite plans for the future of some parts of this plant, it was decided that a surface condenser would be of great value in enabling the plant operating personnel to carry the most economical loading of the generating equipment. It is not expected that this condenser will be used for any great portion of the time or for heavy loads; but rather that it will be available to condense the minimum amount of cooling steam required to be passed through the turbine.

Control by Generator Load and Extraction Pressure

Control of the load to be carried by the generator has been given careful consideration; steam flow to the turbine will be controlled by a dual system—by load on the generator and by pressure at the extraction point. If the operator is required to carry a continuous load on the generator in the face of a fluctuating plant steam demand, the load controlling element will pass sufficient steam through the throttle to maintain the turbine speed, and the extraction pressure control element will vary the throttle opening as required to maintain the extraction pressures. Increase of extraction pressure due to lessening of the

Table I. Example of application of utility company's wholesale power and lighting rate

Demand or KW Charge	
11,000 kw at $1.10 per kw + $410	$12,510.00
Energy or kwhr Charge	
5,000,000 kwhr at $0.005 + $2200	27,200.00
Total	39,710.00
Less Discount 10% not exceeding $3000 per month	3,000.00
	36,710.00
Fuel adjustment charge at $0.00123 per kwhr	6,150.00
Net Cost per Month	$42,860.00
Average Cost per kwhr	$0.008572

Table II. Example of application of public utility company's auxiliary or breakdown rate

Contract Capacity Charge 11,000 kw	
$0.60 per kw + $135	$ 6,735.00
Demand Charge 11,000 kw	
$0.60 per kw + $135	6,735.00
Energy Charge 5,000,000 kwhr	
$0.005 per kwhr + $2215	27,215.00
Total	40,685.00
Less Discount 10% not exceeding $3000 per month	3,000.00
	37,685.00
Fuel adjustment charge at $0.00123 per kwhr	6,150.00
Net Cost per Month	$43,835.00
Average Cost per kwhr	$0.008767

Table III. Monthly cost of power generated by condensing extraction turbine generator when contract demand is at maximum

Contract demand charge 11,000 kw	$ 6,735.00	
Actual demand charge 7,000 kw	4,335.00	
Energy charge (2,500,000 kwhr × $0.005) + $2215	14,715.00	
	25,785.00	
Less 10% Discount Pri. Service	2,578.50	
		$23,206.50
Average Fuel adj. charge 2,500,000 kwhr at $0.00123		3,075.00
Total purchased power charge		$26,281.50
Generation		
1,750,000 kwhr at $0.0017 (Fuel Cost)	$2975	
1,000,000 kwhr at $0.005 (Fuel Cost)	$5000	
	$7975	
Total per Month		$ 34,356.50
Total per Year Cost of Ex. Turb. Gen. Power		407,178.00
Total per Year Cost of Purchased Power		$543,834.00
Differential		$136,656.00

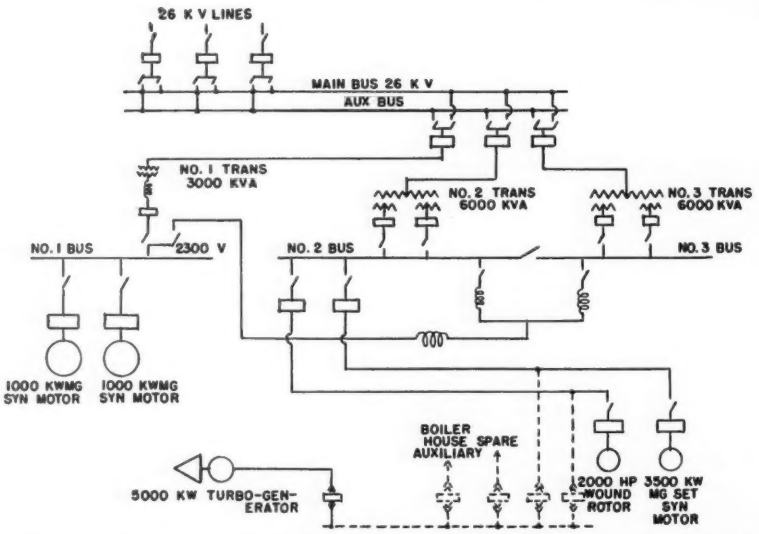


Fig. 5. One-line electrical diagram showing how new 5000-kw turbine generator will supply power to secondary distribution of Roebling plant in parallel with purchased power

plant steam demand will automatically reduce the throttle opening as well as increase the openings in the ports leading from the extraction point to the low pressure stages, thus allowing more steam to pass to the condenser. This control results in a unit capable of carrying a constant load without serious control problems arising from the variations in plant steam demand.

Turbine generator manufacturers' data show that power can be generated by the single-extraction type turbine with 600 psi, 750 F, steam at throttle, extraction at 150 psi 510 F with a rate of 5000 Btu per kwhr or less, an overall efficiency of the turbine generator of 71.5 per cent. With the use of modern steam generating units that operate at a monthly efficiency of 85 per cent, net overall efficiency of such generation is 60.7 per cent. With fuel costs, in the area in which this plant is located, in the range of $0.30 per million Btu power generated at 5000 Btu per kwhr and minimum steam to condenser, fuel cost to generate power is $0.0017 per kwhr under those conditions.

How Purchased Power Charges Are Figured

Electrical power used in this plant has for the past several years been purchased from the public utility company in this area, at their published Wholesale Power & Lighting Service rate; shown in Table I. This shows that the lower the demand and the higher the load factor, the lower the net cost of power.

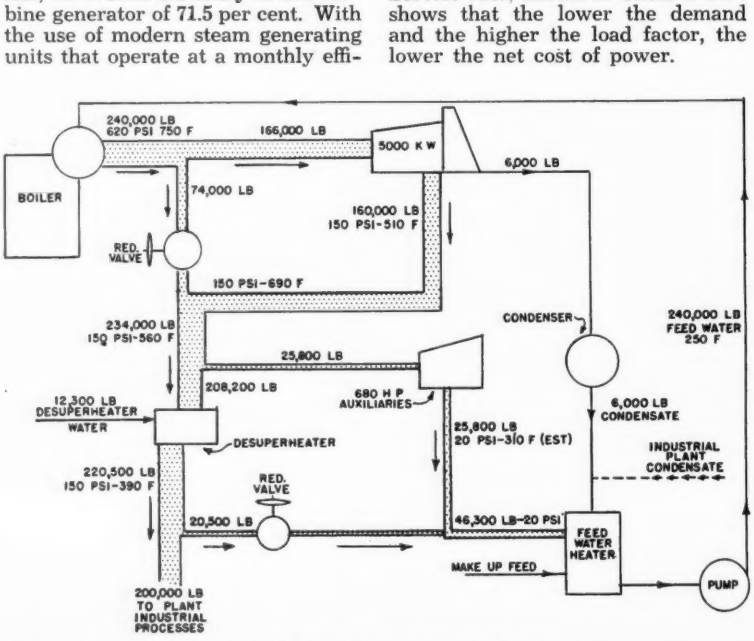


Fig. 6. Steam flow diagram and full load heat balance data for new steam generating units and 5000-kw turbine generator at Roebling plant

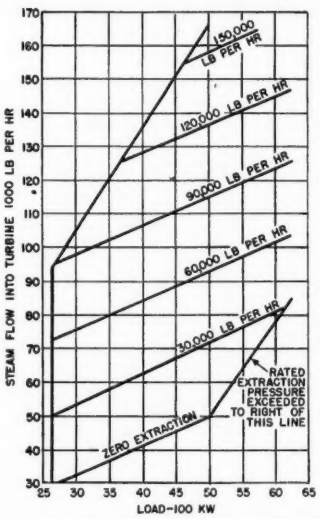

STEAM FLOW INTO TURBINE 1000 LB PER HR
LOAD-100 KW
150,000 LB PER HR
120,000 LB PER HR
90,000 LB PER HR
60,000 LB PER HR
30,000 LB PER HR
ZERO EXTRACTION
RATED EXTRACTION PRESSURE EXCEEDED TO RIGHT OF THIS LINE

Fig. 7. Performance curves for a 5000-kw condensing single extraction turbine; throttle steam 600 psig 750 F; extraction at 150 psig, 510 F; exhaust 2 in. Hg abs; cooling steam 5700 lb per hr

At this plant, we have been able to operate during the past year with a maximum demand of 11,000 kw and a monthly consumption of 5,250,000 kwhr with the plant operating on a 5-day, 3-shift basis, the load on non-operating days being only about 1000 kw. This means that we have an average of 21 operating days per month and 9 non-operating days. This shows an overall load factor of nearly 64 per cent, but, if the non-operating days are not considered, then we have a consumption of 5,034,000 kwhr with 504 hr of operation, a load factor of nearly 91 per cent.

In addition to the rate shown in Table I, the utility company also made a fuel adjustment charge whenever their fuel costs exceed 22.5 cents per million Btu. This fuel adjustment charge has ranged from $0.0009 to $0.00153 per kwhr for the past year with an average of $0.00123 per kwhr, as the average cost of power at the previously mentioned rate for the period studied was $0.00747 per kwhr and the average fuel adjustment charge was $0.00123. The total net cost of power averaged $0.0087 per kwhr.

This utility company also has an auxiliary or breakdown rate, which it applies to customers who generate all or part of their electric power requirements, as shown in Table II. This rate makes a charge per kilowatt demand per month for the contracted load with an additional charge per kilowatt demand actually made. This charge, together with the energy and fuel adjustment charges, makes up the total power cost.

As shown, the average cost of power at this plant was $0.0087 per kwhr, which represents an annual

power cost of $543,834 for 62,400,000 kwhr, the estimated annual consumption.

By the installation of an extraction turbine generator, it is possible to generate a large portion of this load at a fuel cost of $0.0017 per kwhr. Monthly cost of power in this case, even when contract demand is set at the maximum, is as in Table III.

The differential shown in Table III does not represent all savings, as an increased labor cost is involved, as well as greater capital investment, but with an estimated expenditure of $30,000 per year to cover operating labor, maintenance, and supplies, there is still $106,656 per year left to cover the fixed charges.

Turbine Generator Details

Generating equipment of the plant will consist of one 5000 kw, 3-phase, 60-cycle, 2400/4160-v generator directly connected to a 650-psi, 750 F condensing extraction turbine arranged for automatic control of extraction pressure at 150 psig; and a 3000-sq ft surface condenser.

Electrical equipment will be of the metal-enclosed type, with air circuit breakers having an interrupting capacity of 250,000 kva at 4160 v and will be connected to the secondary distribution system of the plant as shown in Fig 7.

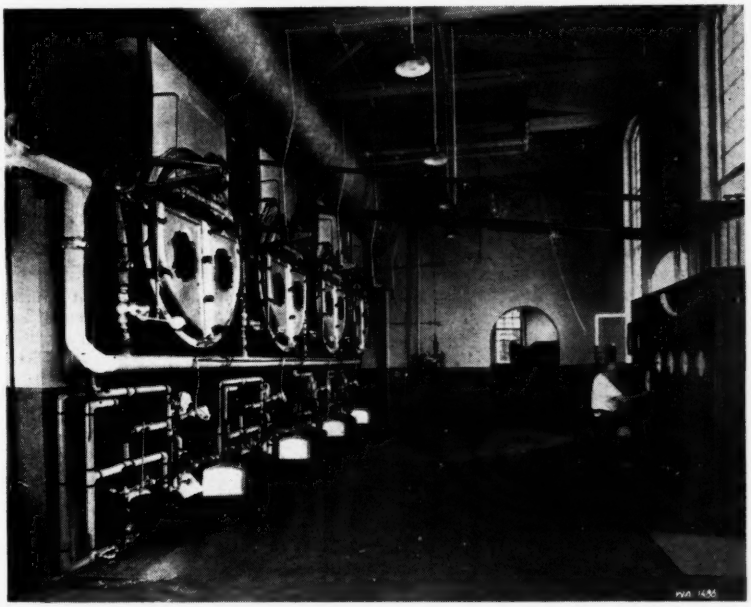
The unit will carry full load during the normal operating shifts of the plant in parallel with the public utility system and during non-operating periods of the plant will operate in parallel with the utility, carry all the plant load, or be shut down as may be determined by need at those times.

By taking a very conservative estimate of 15 years for the life of this equipment, this being influenced by the fact that it is installed in a steel plant that may have changed conditions that will affect the plant power requirements, it is apparent that with depreciation even at this accelerated rate there would remain a saving equal to approximately 25 per cent of the original investment.

Flame-failure Controls Protect Boilers at U.S. Rubber Plant

THE United States Rubber Co. has spent many thousands of dollars modernizing the boiler room of its Woonsocket, Rhode Island, plant. During the war this plant produced such products as barrage balloons, inflatable boats and rafts, and protective rubber lifesaving suits; now it is one of the largest in the country making tennis shoes and waterproof footwear.

One of the problems encountered was that of fuel selection. The four 170 horsepower horizontal return tube boilers had been on coal, but were changed over to oil operation after a cost study showed that a saving in cost would result over a period of years. Bunker C fuel oil is now used. The installation was made by the plant electrical department under the supervision of the Cochrane Steam Specialty Co. of Boston, Mass., New England Wheelco Sales Agents. Andrew Goettman is power engineer in the Woonsocket plant.



View of boiler room at U. S. Rubber Plant. Flame-otrols mounted on panel at right.

One of the essentials of any oil-fired boiler is the necessity of insuring against failure of ignition. Even a momentary loss of ignition is liable to result in a disasterous explosion as a consequence of the accumulation of volatile gas.

At the U. S. Rubber plant protection against flame failure is provided by the installation of four Wheelco Flame-otrols, one for each boiler.

Each Flame-otrol installation consists externally of a Flame-eye (with gas firing the sensing element would be an electrode), in which is incorporated a photoelectric cell.

Internally the Flame-otrol unit includes a single radio-type tube, transformer, relay and associate parts. The operation of the Flame-otrol is based on these factors: 1) Resistance (or conductivity) change in an alternating current circuit changes both the voltage distribution and the phase of the voltage, and 2) a small change in voltage phase can be translated into a large change of current by a vacuum tube. In operation, when a flame reacts on the Flame-eye (or electrode), the resulting circuit has a definite amount of electrical conductivity which causes the armature of the Flame-otrol relay to be pulled up, completing the valve circuit that opens the fuel valves. With flame failure, the conductivity is lower than the specific amount, releasing the relay armature and causing the fuel valves to close. In case of accidental grounding of the electrode (as used for gas fuel) the circuit conductivity increases above the specific Flame-otrol operating range and the fuel valves close.

CORRECTION: WHAT DO YOU MEAN BY THERMAL EFFICIENCY?

WE REGRET VERY much an unfortunate typographical error in the two basic efficiency equations on page 58 of Allen Keller's article on thermal efficiency in the July issue. In both of these equations the numerator and denominator were transposed. The equation in the center column should read:

$$\text{Efficiency} = \frac{\text{Output}}{\text{Input}}$$

The equation in column 3 should read:

$$\text{Efficiency} = \frac{\text{Useful output}}{\text{Input}}$$

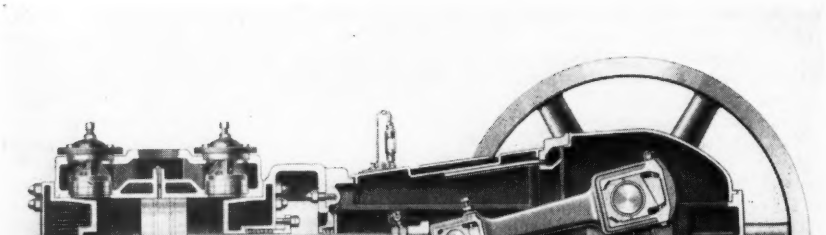


Fig. 1. Cut-away view of air compressor utilizing the splash circulating oil system. (Photo. Ingersoll-Rand Co.)

Proper Air Compressor Lubrication Promotes Efficiency

By THOMAS TRAIL

SATISFACTORY air compressor lubrication depends in a large measure on using the proper kind of lubricant. The type of compressor, size and application will all directly influence the choice of lubricant and the lubrication procedure.

In the air cylinder, lubricating oil has three functions. It reduces friction between the rubbing surfaces, provides piston ring seal and serves as a coolant.

Heat is generated inside the compressor cylinder both by friction between the rubbing surfaces and by the compressing of the air. In addition, the oil is in direct contact with the heated air. The result is that the oil is reduced in viscosity, and the heated air accelerates oxidation, gum formation and the accumulation of carbonaceous deposits. Lubricating oils steadily subjected to oxidizing atmospheres will deteriorate very rapidly; even the best oils will fail in time.

When air is compressed and then cooled in intercoolers, water vapor is precipitated. Separators remove most of this moisture but some of it gets by and remains in the air. When this moisture reaches the following compression stage it tends to replace straight mineral oil on the cylinder walls. Sometimes this moist air will cause rusting or corrosion of the valves, or it may result in sludge formation.

To overcome the effects of heat on the lubricating oil, it is general practice to employ the lowest viscosity oil possible that will spread over the friction surfaces quickly and thoroughly and have good heat dissipating qualities. But the oil must also have a flash point sufficiently above the terminal temperature of the compressed air to insure against possible flares from explosive mixtures. A satisfactory oil must also possess good oxidation and heat resistance and leave a minimum of carbon deposit.

Where moisture in the air presents a problem, oils compounded with a certain amount of saponifiable material, to improve their ability to adhere to the cylinder walls in the presence of moisture and to minimize rusting, are employed.

In lubricating compressor cylinders, it is very important to feed the proper amount of lubricating oil. The smallest quantity that will lubricate the cylinder working parts, preserve the valve parts from pitting or rusting, and maintain the oil film necessary to insure a good piston ring seal is the correct amount.

The best method of determining proper oil feed is to examine the inlet and discharge valves periodically. The valves should not be dry. They should have a greasy appearance but should not have any carbon deposits. The presence of carbon means either that too much oil is being used or that the intake air is dirty. Of course, this is assuming that the proper grade of oil is being used. Improper oil, even in correct quantities, can cause excessive carbon deposits. Carbon formation results in leaky valves and excessive heat and may even lead to self-ignition and the consequent danger of explosion.

The accompanying table gives the minimum rate of oil feed required by air cylinders when operating under near ideal conditions. The quantities shown will need to be increased when handling wet or dirty air (more of an increase being required with straight mineral oils than with compound oils) or when other conditions warrant it. The lubricator manufacturer's instructions should be carefully followed when regulating the rate of cylinder oil feed.

On a new compressor, from two to three times this amount of oil should be fed to the air cylinders for a few days, then the rate of feed can be reduced to about one-half of these amounts. It is then important to examine the valves frequently until the correct quantity of oil required has been determined.

If the intake air is not being properly filtered, dirt and suspended foreign material may be drawn into the compressor cylinder. This is likely to interfere seriously with proper lubrication and cause excessive wear of cylinder, piston, rings, valves, etc. An examination of the air passages of the cylinder should

be made periodically to check for dirt on the walls and in the pockets. The presence of dirt indicates that the air intake requires immediate attention.

Whenever the cylinder requires cleaning, fill the lubricator reservoir with strong soap suds or a water solution of washing soda and allow this to feed freely into the cylinder. This is a very effective method, but the solution should not be allowed to remain too long in the system since it is likely to corrode the lubricator parts and the cylinder surfaces. For this reason the compressor should not be shut down until oil has been replaced in the lubricator and the machine run long enough to insure normal cylinder lubrication. On lubricators equipped with glycerine and water sight feeds, these must be refilled each time after cleaning the cylinder.

Where solvents are employed to clean the air cylinder, only those of the safety type should be used. Inflammable solvents should never be used because of the danger of explosion.

On the smaller compressors that do not have crossheads, the cylinder oil lubricator is dispensed with. Usually one of two systems is employed. In the constant-level-splash type the action of the connecting rods dipping into oil filled troughs creates a mist or fog that lubricates all friction surfaces, including air cylinders.

Where pressure oiling is employed, usually the air cylinders are lubricated by oil that weeps out of the sides of the main and connecting rod bearings.

On some compressors equipped with a pressure lubricator to supply oil to the air cylinder, the same lubricator also furnishes oil to the stuffing box packing.

Compressor cylinder lubricators vary somewhat in style and operation. They are made in single and multi unit styles, an individual unit being provided for each point that requires lubrication. Lubricators are usually driven directly from the compressor crosshead, and, when properly installed and fitted, start supplying lubrication as soon as the compressor starts operating and stop lubrication when the machine is shut down.

The instructions of the lubricator manufacturer should be followed as to adjustment and care of the device. If the lubricator stops feeding due to lack of oil in the reservoir, it will be necessary to prime it. Various methods are employed on the different types of lubricators to accomplish this. Adjustment is also provided for regulating the rate of feed of each unit independently.

On lubricators having a glycerine and water sight feed, in time the glycerine mixture will be carried out with the oil. This has no harmful effect on the cylinder lubrication but the mixture should be replaced in order to observe the oil feed. The manufacturer's instructions should be followed as to the correct procedure.

Where compressed air is used in the processing of food or beverages, and the air comes into contact with them, precautions should be taken to prevent their contamination by oil that may be in the air. Where only the question of odor is involved, a highly refined, water white pure oil should be employed. For cases where any kind of oil is objectionable, some compressor manufacturers make non-lubricated cylinders in which the pistons are fitted with graphitic carbon wearing rings and pressure rings which need no lubricant.

Where commercial gases are compressed instead of air, special lubrication procedures are necesary since some gases dilute mineral oils while others affect them chemically. The advice of a lubrication engineer should be followed in such cases. He will be able to recommend the proper oil to use for the particular operation.

An aftercooler is a very desirable part of an air compressor installation. It will remove the greater part of the moisture contained in the intake air before it is delivered to the receiver. This is especially important where the air is used in air-operated tools and machines.

The running gear of an air compressor requires a different lubrication procedure from that of the air cylinder. However, the oil used may be the same as is used for single stage compressor cylinder lubrication, where the air is dry. The crankcase oil should be inspected at

(Continued on page 110)

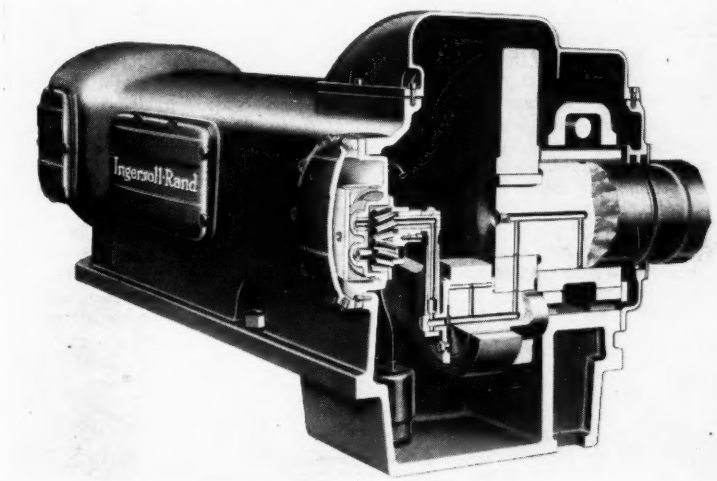


Fig. 2. (Above) Sealed frame air compressor construction showing built-in oil pump

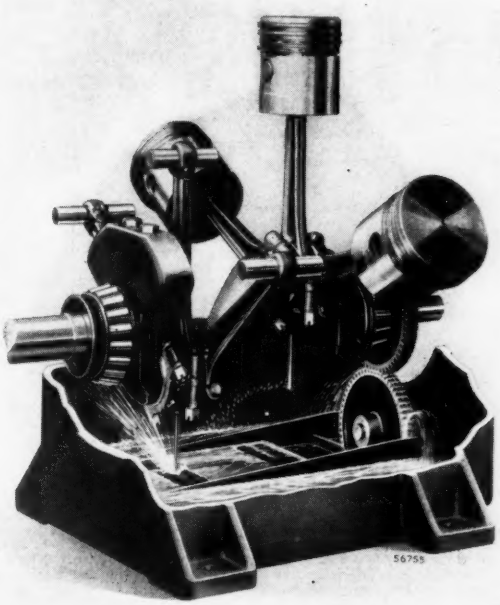


Fig. 3. (Right) An air compressor employing the constant-level splash oiling system. (Photos. Ingersoll-Rand Co.)

Chemical Feed Systems in Modern Water Treatment

By **JAMES H. RICHARDS**
Chemical Engineer,
W. H. & L. D. Betz

Part I—Chemical treatment now applied to practically all water supplies . . . Proper application of treatment has necessitated development of many types of chemical feeders and feed systems . . . These are described and their operation and application discussed in detail . . . This first part of a 2-part article deals with wet or solution type feeders, including shot feed systems and constant-rate feeders . . . Shot feed systems include pot type feeders, water jet eductors and automatic shot feeders . . . Constant-rate feeders include controlled-volume pumps and drip feeders . . . Part II in a future issue will cover proportional feed systems and dry-type feeders and applications

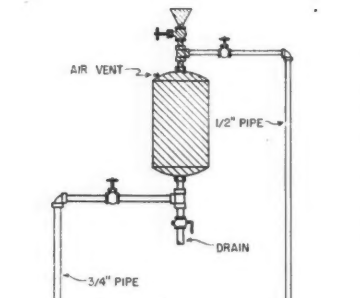


Fig. 1. Diagram of a pot type shot feeder for chemicals, connected across boiler feed pump in manner shown

NECESSITY of applying chemical treatment to practically all water supplies, for the purpose of achieving a desirable water, is an accepted fact. Proper application of treatment has required development of chemical feeders of many types. It is the purpose of this article to discuss the application of the more general types of feeders as may be used in applying chemical conditioning to boiler feedwater and boiler water, hot and cold water distribution systems, cooling systems, sewage effluents, process wastes and the like.

Types of chemical feed equipment can be divided into two general classifications: dry type feeders and wet or solution type feeders. The systems may be classified also on the basis of rate of feed, whether constant or proportional. Solution type feeders may be further described as gravity or pressure type.

The dry type feeders are usually applied when large quantities of chemicals must be handled. For this reason, their application is common to sewage and process waste treatment plants, municipal, and large industrial water treatment plants when chemicals such as lime, soda ash, and alum must be handled in large quantities. They are discussed in Part II of this article, which also includes a table showing application and types of feeders used for all water treatment processes.

The solution type feeder is usually

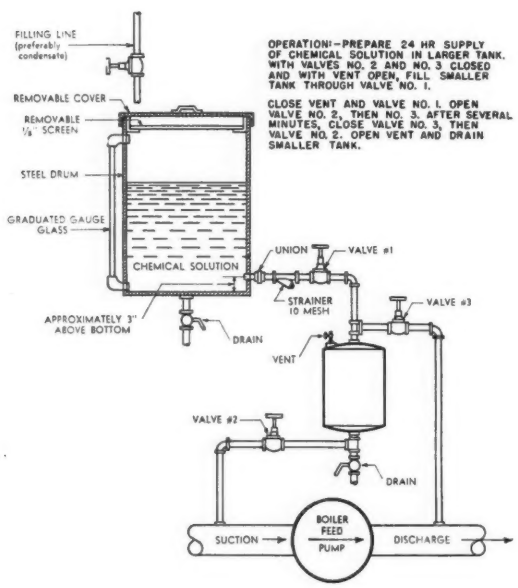

FILLING LINE (preferably condensate)
REMOVABLE COVER
REMOVABLE 1/8" SCREEN
STEEL DRUM
GRADUATED GAUGE GLASS
CHEMICAL SOLUTION
APPROXIMATELY 3" ABOVE BOTTOM
OPERATION!—PREPARE 24 HR SUPPLY OF CHEMICAL SOLUTION IN LARGER TANK. WITH VALVES NO. 2 AND NO. 3 CLOSED AND WITH VENT OPEN, FILL SMALLER TANK THROUGH VALVE NO. 1.
CLOSE VENT AND VALVE NO. 1. OPEN VALVE NO. 2, THEN NO. 3. AFTER SEVERAL MINUTES, CLOSE VALVE NO. 3, THEN VALVE NO. 2. OPEN VENT AND DRAIN SMALLER TANK.
UNION
VALVE #1
STRAINER 10 MESH
VALVE #3
DRAIN
VENT
VALVE #2
DRAIN
SUCTION
BOILER FEED PUMP
DISCHARGE

Fig. 2. Diagram of shot feeder for chemicals, with mixing tank

Size of the two tanks should be so related that a 24-hr treatment supply can be prepared at one time. If treatment is shot fed once per hour, the larger tank should have 24 times the capacity of the smaller; if treatment is shot fed every 4 hours, larger tank should be at least 6 times the capacity of the smaller; and so on. The larger tank should be large enough so that treatment concentration does not exceed a 5 per cent solution. Minimum pipe size should be ½ in. All valves should be globe valves

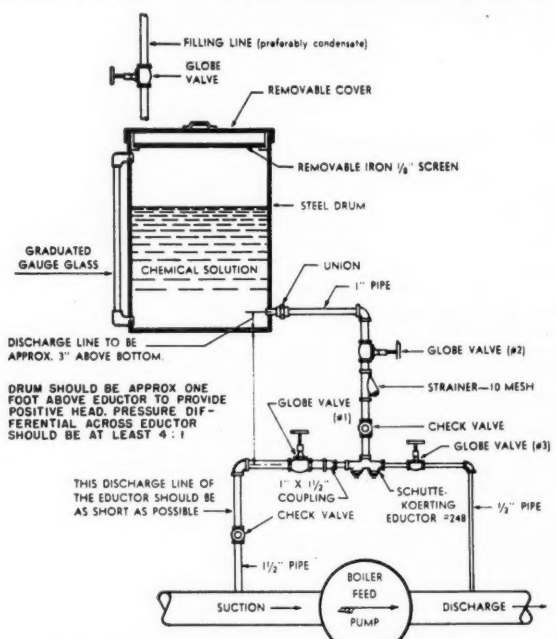

FILLING LINE (preferably condensate)
GLOBE VALVE
REMOVABLE COVER
REMOVABLE IRON 1/8" SCREEN
STEEL DRUM
GRADUATED GAUGE GLASS
CHEMICAL SOLUTION
UNION
1" PIPE
DISCHARGE LINE TO BE APPROX. 3" ABOVE BOTTOM.
GLOBE VALVE (#2)
STRAINER—10 MESH
DRUM SHOULD BE APPROX ONE FOOT ABOVE EDUCTOR TO PROVIDE POSITIVE HEAD. PRESSURE DIFFERENTIAL ACROSS EDUCTOR SHOULD BE AT LEAST 4 : 1
GLOBE VALVE (#1)
CHECK VALVE
GLOBE VALVE (#3)
THIS DISCHARGE LINE OF THE EDUCTOR SHOULD BE AS SHORT AS POSSIBLE
1" X 1½" COUPLING
SCHUTTE-KOERTING EDUCTOR #248
½" PIPE
CHECK VALVE
1½" PIPE
SUCTION
BOILER FEED PUMP
DISCHARGE
TO START FLOW OF CHEMICAL SOLUTION FROM DRUM TO BOILER FEEDWATER SUPPLY
FIRST: OPEN VALVE NO. 1
SECOND: OPEN VALVE NO. 2
LAST: OPEN VALVE NO. 3
TO STOP FLOW OF CHEMICAL SOLUTION FROM DRUM TO BOILER FEEDWATER SUPPLY
FIRST: CLOSE VALVE NO. 2
SECOND: CLOSE VALVE NO. 3
LAST: CLOSE VALVE NO. 1

Fig. 3. Diagram showing how water jet eductor is used in shot feeding system for chemicals

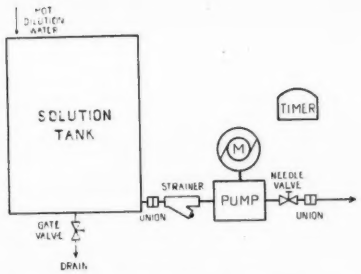
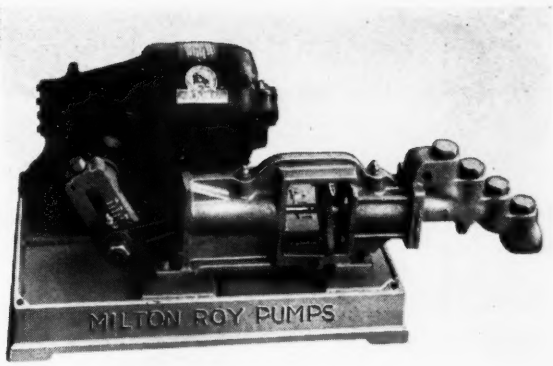


Fig. 4. Diagram of automatic chemical shot feeding system, employing a small gear pump, timer controlled. System feeds to suction side of boiler feed pump

Fig. 5. Motor-driven controlled volume pump. (Milton Roy Co. photo)



employed when the chemical to be fed cannot be satisfactorily handled by dry feeding equipment. Hygroscopic salts, such as ferric coagulants, are examples of materials that must be fed in solution form. Also, when small quantities of chemicals are to be added, solution feeders provide greater convenience and accuracy. For this reason, solution feeders are used almost exclusively in the addition of chemicals to boilers for secondary treatment of the boiler water, for prevention of scale deposits and corrosion. External softening or other pretreatment of the boiler make-up water is usually considered the primary treatment.

Wet or Solution Type Feeders

Chemical feeders for the addition of water treatment chemicals are of the "shot feed," constant rate and proportional feed types. The type of feed system that should be employed in any individual instance depends upon a number of factors, such as: amount and type of chemcials and for what purpose they are being used; type and capacity of boilers; whether the feedwater passes through stage heaters and economizers, and so on. For example, feed of sodium sulfite for oxygen elimination should be continuous to the storage section of the heater or suction side of the boiler feed pump for most effective results. This system would require a suitable chemical pump or similar device for the continuous feed of treating solution. On the other hand, the phosphates normally used for boiler water conditioning may be shot fed through the feedlines to the boilers, provided stage heaters or economizers are not used and the number of boilers to be so treated is restricted to approximately two or three.

The methods of feed are outlined with a discussion of the applications and limitations of each system.

Shot Feed Systems

These systems are subdivided into pot type feeders, eductor systems and automatic shot feed arrangements, in which the object of the feeding device is to rapidly introduce a unit charge of chemical treatment. Usually these systems are employed to avoid feedline deposits that might result from continuous chemical feed.

Pot Type Feeders:—Probably the oldest method used for the introduction of chemicals to boilers is the "pot" type shot feeder which consists of a pressure tank and fittings as shown in Fig. 1. The chemical charge is prepared by dissolving the chemicals in a bucket and then filling the pressure tank with the solution. It is necessary, of course, to drain water from the tank and open the air vent prior to pouring the chemical solution into the tank. The illustration shows the feeder connected across the boiler feed pump. Feedwater from the pressure side of the pump forces the chemical solution into the suction side of the pump. Within a few minutes, the solution will be washed out of the pressure tank and will be injected into the boiler shortly thereafter.

A system of this type is usually satisfactorily applied when the number of "shots" per day does not exceed three or four. If more frequent "shots" are required, it is possible to install a large mixing tank above the pressure tank, similar to the tank shown in Fig. 2, thus eliminating the inconvenience of dissolving chemicals each time an addition of treatment is necessary.

Pot type feeders are frequently

(Continued on page 122)

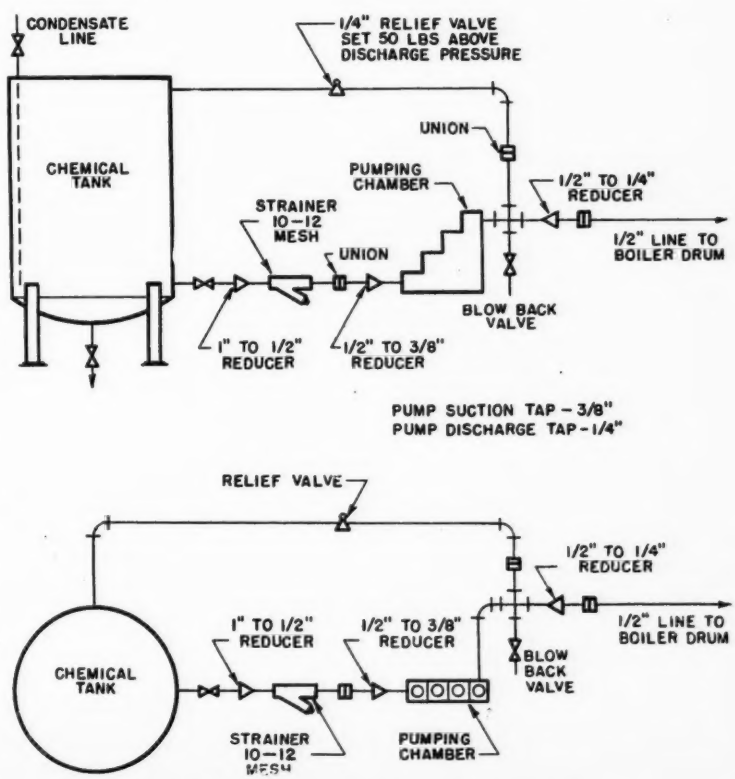
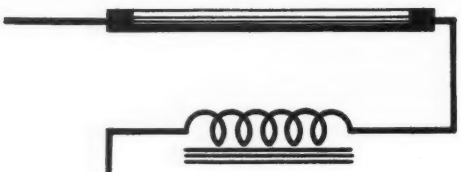


Fig. 6. Diagram of piping for chemical pump installation



Fluorescent Lamp Ballasts —

What They Are, How They Work and How to Install Them

By C. P. HAYES
Specialty Transformer Engineering Division,
General Electric Company, Ft. Wayne, Indiana

OF THE MILLIONS of people all over the world who see by fluorescent lamps very few ever give a thought to the "ballast" which makes the fluorescent lamp possible, indeed, only few people know that such ballasts are necessary.

The fluorescent lamp ballast is as necessary a part of the lamp as the cathodes or the phosphor with which the inside of the lamp tubes are coated. Unfortunately, its physical size and weight makes it impossible to incorporate the ballast in the construction of the lamp itself; if they could be made small and light enough, they certainly would be made integral with the lamp itself because they form a most vital part of the lamp circuit.

One of the first questions that one may ask is, "why are fluorescent lamp ballasts necessary?"

The answer is, that the fluorescent lamp is basically an "arc" and an arc has what is known as a negative impedance characteristic, that is, its impedance varies inversely as the current through it. In other words, if the current tends to increase, the impedance tends to decrease. This decrease in impedance, assuming that the arc is supplied from a constant potential circuit, tends to increase the current still more with a further decrease in impedance. A continuation of this action rapidly results in a condition of instability and in less time than it takes to tell a short circuit ensues.

By placing a resistance or impedance in series with an arc, whenever the current through the arc tends to increase, with consequent decrease in resistance or impedance, the current through the external impedance will tend to increase also (since the two are in series) but an increase in current through the impedance results in an *increase* in impedance. This increase in impedance is just enough to balance the decrease in impedance across the arc. Thus the system remains stable.

This, then, explains why the fluorescent lamp ballast is necessary—to limit the lamp current to its proper value after it starts.

To understand how the ballast is connected into the fluorescent lamp circuit it is necessary, briefly, to consider the construction of the lamp itself. Basically, the fluorescent lamp consists of a glass tube having a cathode, or electrode, at each end. These cathodes look much like ordinary incandescent lamp filaments but perform a different function. The tube is evacuated and a small amount of mercury is placed in it at the time the lamp is sealed. The inside of the tube is coated with what is known as a phosphor, a material which fluoresces under the action of ultraviolet radiation.

The cathodes at each end of the tube can be heated by passing current through them. When this is done, electrons are emitted by thermionic action exactly as they are in a radio tube and, if a voltage is applied between the electrodes a mercury vapor arc will be formed. The heat from the cathodes, of course, serves to vaporize the mercury contained in the tube.

The mercury arc which is formed

Here is an article about a device which is seldom seen but which, nevertheless is as important a part of the fluorescent lamp circuit as the fluorescent lamp itself. This is the ballast. As explained in this article the fluorescent lamp is essentially an arc and since an arc has a negative impedance characteristic, it needs a stabilizing device of some kind of series with it. This in the alternating current type of lamp is usually a series impedance. The design of this impedance is rather critical and the efficiency of the fluorescent lamp and to a large extent its life depends upon the proper design and construction of the ballast. So, in this article, the author discusses the principles and design of these ballasts so that you will know how to select and install them properly

does not emit much visible light but it is a rich source of ultraviolet light. This ultraviolet radiation excites the phosphor which coats the inside of the tube causing it to fluoresce and it is this fluorescence that produces the characteristic light that has become so popular in recent years. By the use of different types of phosphors, different colored light can be produced.

The electrodes need to be preheated only when the lamp is started so a starting switch is usually provided to provide the proper interval for this preheating. The starting switch closes the circuit through the cathodes for a short time so as to produce the necessary electron emission and then, automatically places a high transient voltage across the lamp to insure positive starting. The voltage necessary to start a fluorescent lamp varies with the size and shape of lamp but it is always considerably greater than the voltage drop across the lamp after normal current is flowing.[1]

Once the lamp is started, the current is limited by the ballast impedance as already explained. If such a ballast is not provided the current will continue to increase until the lamp fails. Usually, this occurs in a few seconds.

Table I shows the cathode heating current, the running currents, the starting voltages and the running voltage for some of the more common lamp ratings.

Typical Ballast Circuits

Various types of ballast circuits are used for various types and sizes of lamps and for various circuit voltages. One of the simplest ballast arrangements obtains when the circuit voltage available is equal to the lamp open circuit voltage. This condition requires only a series impedance. Such an impedance might be a resistance, but the losses in this type of current limiter are unnecessarily high for best economy and it does not produce good current wave shape when operated in series with an arc discharge such as characterized by the fluorescent lamp. Where fluorescent lamps are operated on direct current circuits it is necessary, however, to use a resistance as ballast since an ordinary a-c impedance offers little impedance to the flow of direct current.

Poor wave shape results in poor lamp efficiency and with alternating current a reactor provides the best known performance and with minimum cost. A simple circuit consisting of a single fluorescent lamp and a series impedance is shown in Fig. 1a. The operation of the circuit is as follows: The switch *S* is closed when it is desired to start the lamp.

[1] For a complete account of the basic principles and characteristics of the fluorescent lamp, see "Fluorescent Lamps and Lighting," Parts I and II, by A. K. Gaetjens in the December, 1945, and January, 1946, issues of *Power Plant Engineering*, respectively.

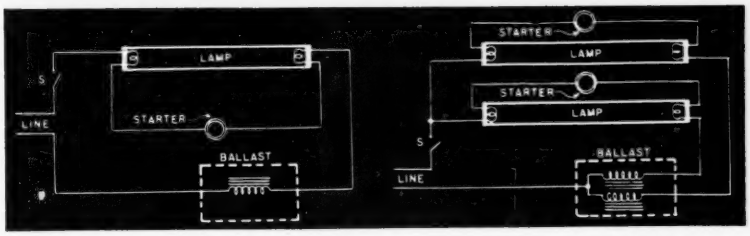


Fig. 1. Circuits showing the use of the reactor type of ballast for one (left) and two (right) lamps

The automatic lamp starter closes, allowing current to flow through the ballast and the two lamp cathodes. Since the voltage drop across the cathodes is very small, a large current flows to warm the cathodes. After a period sufficiently long to warm the cathodes has elapsed, the starter automatically opens the short circuit across the lamp. The high transient voltage[2] thus produced is sufficient to initiate current flow through the lamp. This voltage drop across the reactor limits the current to the proper value.

Figure 1b shows a combination of two series reactors for operating two lamps. It should be noted that only one lamp can be operated from one reactor, because the unstable lamp arc characteristics will not guarantee proper division of current if more than one lamp is fed by a single reactor. The double lamp ballast consists of two single reactors. They are placed in a single enclosure and only three leads are brought out. The only reason for such a ballast is that some economy can be realized by this combination where the lamps are used in pairs, as in two lamp fixtures. Operation is the same as in Fig. 1a.

Many larger lamps require starting voltages in excess of the normal circuit voltage available. For these cases the circuit in Fig. 1a is modified to add an autotransformer, as shown in Fig. 2a. The autotransformer raises the voltage to the necessary value and operation is otherwise like Fig. 1a. Inspection of Table I will show that all lamps with greater wattages than 20 require the auto-transformer when operating from 118 v supply circuits.

A more common type of ballast is that shown in Fig. 2b. The circuit provides for operation of higher voltage lamps from low voltage circuits by use of the autotransformer. One lamp has a reactor in series with it as in Fig. 2a. The other lamp has a reactor and capacitor in series. The reactor lamp circuit operates at a power factor which is very heavily lagging.

The capacitor and reactor of the other lamp are so designed and adjusted that the power factor is leading by a value very close to the lag of the first lamp. The resultant load on the autotransformer is approximately unity power factor, which reduces the size of the auto-transformer. A capacitor and a reactor are used in series, although they tend to cancel each other, because reactive impedance is required to maintain good wave shape. The capacitor predominates to make the circuit leading power factor, but the reactor provides a high impedance to the higher harmonics of current which would be present were it not for the reactor. The resultant overall high power factor of this type ballast is very desirable because of the lower line regulation, smaller cable, and more favorable power rates.

The ballast circuit in Fig. 2b has one fault. The reactor-capacitor circuit in the "lead" circuit because of its leading power factor, has inherently low current under the starting condition. In order to provide better starting current in the lead circuit lamp, many of the better ballasts have a further modification as shown in Fig. 3. A compensator winding is added to lower the impedance of the

[2] The high transient voltage is of course due to the inductive effect of the reactor which constitutes the ballast.

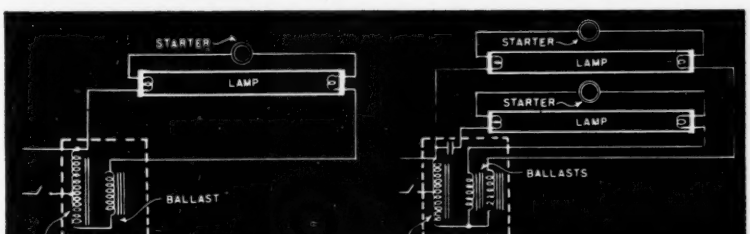


Fig. 2. Two circuits showing the use of auto-transformers in combination with reactors and capacitors. In Fig. 2a is shown an auto-transformer plus a reactor for a higher voltage single lamp. At 2b is shown an auto-transformer plus a capacitor together with reactors for two lamps

circuit under the starting condition. As soon as the lamp starter opens the circuit to start the lamp, the compensator is removed from the circuit, as will be seen by inspection of Fig. 3. The use of the compensator is more expensive because of the greater ballast cost and more fixture wiring, but it is paid for many times in longer lamp life. This type of ballast with built-in compensator has proved extremely popular for two lamp or four lamp fluorescent fixtures using lamps rated at 30 and 40 watts.

There is a considerable usage of three lamp fixtures and many manufacturers prefer a three lamp ballast for minimum cost and installation expense. Such a circuit is shown in Fig. 4. The circuit shown is identical to Fig. 3 except for an additional "lag" circuit added to operate the third lamp. Since this lowers the

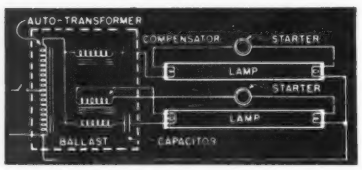


Fig. 3. A double lamp ballast showing the use of the compensator

overall power factor, a capacitor (A) is added across the auto-transformer output to restore the power factor to a value near unity.

Such a capacitor can be added to a single lamp ballast to correct the power factor, as shown in Fig. 5.

Four-lamp ballasts have been built but they are not common. Four lamp fixtures are usually equipped with two double lamp ballasts.

Instant Starting

The types of ballast circuits discussed so far have been for use with lamps requiring preheated cathodes. Instant starting lamps are also available which have a different type of cathode adapted to this service. In order to start such a lamp, higher voltages are required as shown in Table I. Instant-starting cathodes are of the filament type, but both ends of the cathode are connected to a single pin.

A 40-watt, instant-start lamp has the bi-pin base, but the pins are short-circuited inside the lamp and will not operate on preheat ballast circuits. The circuit for the double lamp instant-starting high power factor ballasts is shown in Fig. 6.

Table I. Currents and voltages for common lamp ratings

Lamp Wattage (Watts)	Lamp Dia. (Inches)	Lamp Length (Inches)	Lamp Current (Amp.)	Lamp Voltage (Volts)	Starting Voltage (Volts)	Starting Current Range (Amps.)
15	1.5	18	.33	48	118	0.44-0.65
20	1.5	24	.365	59	118	0.44-0.65
30	1	36	.355	98	200	0.44-0.65
40	1.5	48	.42	106	200	0.55-0.75
100	2.5	60	1.5	72	150	1.35-2.70
40	1.5	48	.42	106	450	.....

Table II. Causes and cures of various fluorescent lamp troubles

Symptom	Cause and Cure
Lamp blinks on and off	1. Faulty lamp, or lamp near end of normal life. Try new lamp. 2. Faulty starter. Try new starter. 3. Low circuit voltage. Correct voltage. 4. Low ballast rating. Replace ballast. 5. Low room temperature or drafts. Raise temperature. 6. Faulty wiring of ballast in fixture. Most ballasts show a wiring diagram on their nameplate. Be sure ballast is wired according to diagram shown.
No starting effort	1. Faulty lamp contact in lampholders. Turn lamp and check contact. 2. Lamp may be open circuited. Replace. 3. Faulty starter. Test with replacing starter. 4. No supply voltage. Check with 115V lamp across ballast input; restore power supply. 5. Faulty ballast. Replace.
Lamp ends remain lighted	1. For new circuits, wiring may be incorrect. Check wiring. 2. Faulty starter. Replace starter.

Since voltages are high in these circuits, the common connection is accomplished in the lamp sockets in such a way that power is removed from the ballast primary when a lamp is removed as in Fig. 2. Since the starting voltage is higher on instant-start lamps, with the same running voltage, the auto-transformer must be larger.

The reactors and the capacitor must also be larger in volt-ampere rating in order to reduce the voltage back to the same running value as the switch-start lamp. These factors make the ballast larger and more expensive. The losses will also be greater for an economical design. Some factors which offset these disadvantages are instant-starting and the elimination of the lamp starter, starter socket, and the additional wiring. The new long lamps in small diameters which are just becoming available are designed for instant-starting and have single pin bases.

Ballast Construction

The basic element of the ballast itself is a reactor. There are one or more reactors in each of the circuits previously described. Basically, a reactor is a coil of wire linking a laminated iron core having an air gap.

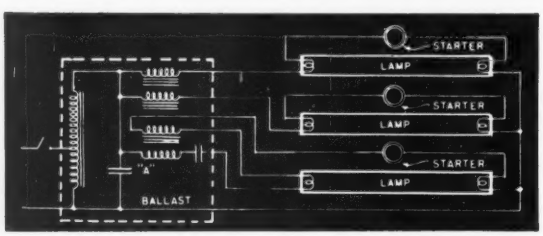


Fig. 4. Circuit for three lamps showing one "lead" and two "lag" circuits

Such a coil, core, and the assembly of these two elements are shown in Fig. 7. The amount of impedance is determined by the cross-section of the iron core, the number of turns in the coil, and the air gap dimensions. The amount of current to be carried, along with other factors, determines the size of the wire.

The core is assembled in the coil with the proper air gap, and clamped rigidly to maintain the adjustment as well as to minimize noise. Various methods are used to do this clamping, which will not be discussed here. This assembly, when treated with insulating varnish and baked out thoroughly, is placed in a metal can. The remaining space in the can is filled with a special compound which helps carry away the heat generator in the ballast. The compound is also very necessary to further secure the assembly against noise.

The auto-transformer looks much like a reactor, except that the winding is composed of two coils, one over the other, and the iron is stacked with inter-leaved joints instead of having an air gap. The double lamp ballasts and auto-transformer types are made up by combining the proper units into an assembly in a proper size can and filling with compound as before. A double lamp ballast for two 40-watt lamps is shown in Fig. 9, with the auto-transformer and two reactors clamped into a single assembly. The capacitor is also shown. Fig. 8 shows a family of double lamp ballast for various lamp sizes.

There are many points where good ballast design and manufacture can contribute to efficient, trouble free,

low cost fluorescent lighting. The proper installation of the ballast in the fixture, as well as fixture design, are also important. The lamp manufacturer specifies the values of current and voltage for starting and running conditions. Consider what happens if the designer ignores these requirements or if insufficient care in manufacture and adjustment allows the ballast to deliver values other than those specified.

If the ballast delivers less current at starting than the minimum value specified by the lamp manufacturer, the cathode will not have reached proper temperature when the lamp starter opens the starting circuit. This will result in flickering and in short lamp life, because of the repeated attempts to start before achieving success.

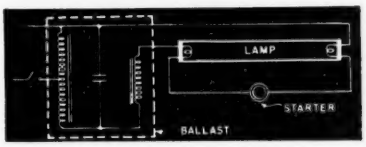


Fig. 5. Circuit for a single lamp using a high power factor ballast

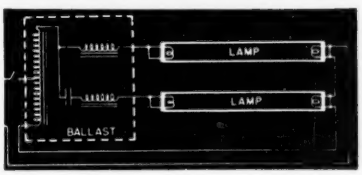


Fig. 6. An instant starting circuit showing safety wiring

Furthermore, if the starting current is too high, the cathodes will heat too quickly and "boil off" an excessive amount of the cathode coating, again causing short lamp life.

If the minimum starting voltage specified is not provided, starting may be erratic and lamp life will be shortened because the lower voltage does not assure positive starting.

Since all power sources vary in voltage to some degree, it is important that the ballast be so designed that these voltage changes produce minimum change in the lamp performance. This is accomplished by good proportioning of the ballast. The range over which the ballast will satisfactorily operate is usually specified on the nameplate. Those responsible for lighting installations should take pains to assume themselves that their power supply does not go outside this voltage range. In general, low voltage tends to reduce light output and impair starting performance. High voltage tends to increase light output and to overheat the ballast.

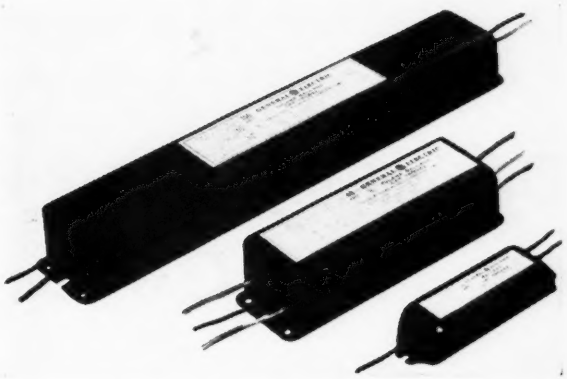


Fig. 8. Three 2-lamp ballasts for fluorescent lamps; 100, 40 and 20 watt capacity, respectively

The distortion of the current wave shape is important to lamp operating characteristics. If the wave is too peaked, short lamp life will result.

Ballast Installation

A good ballast, well designed and carefully built can still fail in its assignment of running the lamp properly for years of trouble-free service. The fluorescent lamp is still a newcomer to the industry, and some manufacturers of fixtures have not yet been convinced that a ballast must be well ventilated and cooled to properly perform its job. The losses of the ballast must find their way out of the fixture along with the lamp losses. If good cooling means are provided in the fixture, the ballast will do a faithful job. But if the ballast is allowed to overheat, short life is bound to result.

The more common methods of cooling are by conduction from the ballast to a cooling surface in the fixture, and by ventilation. In order to insure maximum conduction of heat from the ballast to the fixture surfaces, the ballast base should be in intimate contact with the mounting surface. The mounting surface should be selected to be the coolest possible location on the fixture. It is frequently necessary to provide further means of cooling in order to maintain safe temperatures on the ballast surface.

Ventilation is the best approach and is accomplished by various means. In general, it may be said that a point of air entry below the ballast and so located that the air must pass over the ballast and out a relief opening above is the most desirable approach. This provides a natural convection, or "chimney" effect, to wipe the heat away from the ballast surface with a wash of air.

The ballast is an electromagnetic device, and as such, tends to produce noise or hum when operated on a-c circuits. This noise can be greatly diminished by good design and careful manufacture. The fixture can also be designed to minimize this factor by using strong sturdy sections with no loose parts, which may rattle and amplify the noise.

It is only good wiring practice to ground the proper lead on the ballast primary except on delta or wye line-to-line circuits. The ballast case should be so installed that the case makes positive connection to the fixture and the fixture should always be grounded. This is particularly true where higher voltage lamps are installed.

Radio Interference

Radio interference is sometimes encountered in fluorescent lamp installations. The source of the interference is in the lamp itself, and can be transmitted for distances of about ten feet directly to the radio antenna or lead-in. In case of direct pick-up the best answer is to move the lamp or radio until at least ten feet of separation is obtained. It can also travel back through the lamp leads, ballast and power supply circuits to the radio. Filters are manufactured which are very effective in eliminating this type of interference, and are usually attached as close to the ballast primary as possible for best results.

Stroboscopic Effects

This topic has been greatly overemphasized in the past for various reasons. The fluorescent lamp light output approaches very closely to zero as the alternating current passes through zero. This is not as true of the incandescent lamp, where the stored heat in the filament tends to hold over some light output dur-

(Continued on page 110)

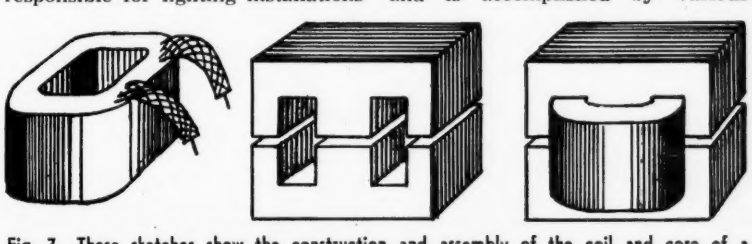


Fig. 7. These sketches show the construction and assembly of the coil and core of a fluorescent lamp ballast

Determining Furnace Heat Transfer by Gas Temperature Measurement

By H. F. MULLIKIN
Department of Mechanical Engineering, Montana State University

OF THE AVAILABLE METHODS of determining the overall furnace heat absorption the most direct is to measure the furnace-outlet gas temperature. For most purposes such as the design of superheaters, this is the final quantity desired. If the furnace-outlet gas temperature is known it is readily possible to calculate the average or mean furnace-heat-transfer rate, a value of interest but one which is not necessarily needed in ordinary boiler design.

It must be realized that local heat-transfer rates at various parts of a furnace wall differ widely and may, at certain locations, be several times the mean value. If the localized heat-absorption rates are measured throughout a furnace it would be possible to calculate the mean heat-absorption rate but the determination of these localized values at a sufficient number of locations to be representative is a difficult and costly procedure, so is not ordinarily attempted.

For calculation of mean heat-absorption rates, accurate measurement of furnace-outlet gas temperatures is necessary. It is important whether this gas temperature be measured by an optical pyrometer, a thermocouple, a radiation pyrometer or other device. The measurement of the temperature of a gas is subject to errors which do not occur in the case of a solid or a liquid.

In boiler furnaces the presence of steam and water-cooled surfaces bounding the furnace increases the error. Suppose it is desired to obtain the gas temperature leaving a water-cooled steam-boiler furnace. An optical or radiation pyrometer sighted into a furnace through a convenient opening "sees" not only the hot gases or flames but also looks at the opposite wall through the gases. The temperature indicated by the pyrometer will then be somewhere between the gas temperature and the wall temperature and may thus be quite low. Even an ordinary thermocouple inserted into the gas stream may read low. This is due to the "radiation" error which is more pronounced for radiation-permeable gases than for liquids.

In the case of liquids, a thermocouple of sufficient length and of ordinary design, immersed in a hot liquid will give the temperature very accurately. Similarly, a thermocouple peened into a solid surface will also give an accurate reading, if certain ordinary precautions are observed. As no heat is lost by the thermocouple it must reach the temperature of the material very rapidly.

On the other hand a different condition exists for a gas. A thermocouple inserted in a gas receives heat by convection from the gas, but there will also be radiant-heat exchange with the furnace walls which it can "see." If the wall surfaces "seen" are at the same temperature as the gas, the thermocouple will read the true temperature of the gas, because no radiant-heat exchange will take place. On the other hand, if the containing walls are hotter than the gas they will radiate heat to the thermocouple which, because of the extra heat received, will read higher than the true gas temperature. If the walls are at a lower temperature, as in the case of a steam-boiler furnace, they will absorb radiant heat from the thermocouple and hence the

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As pointed out by the author the most direct method of determining the overall furnace heat absorption is by measuring the furnace gas outlet temperature. In steam boiler desgin, particularly in connection with the design of the superheater setting it is desirable to predict the gas temperature leaving the furnace. While some formulas for predicting such temperatures have been advanced (2) they are not of general validity, hence boiler designers have been forced to base their new designs on test data from operating units of similar construction.

It has been found that operating factors are nearly as important as construction details and a correlation of all the factors would be quite difficult. In this article the author attempts to indicate certain general conclusions based on test data but for accurate work, designers must still rely on huge amounts of performance data in their files rather than simple graphic relations. The subject of furnace performance factors which affect heat transfer is receiving considerable study at present (9) by operating utilities. The present article discusses test procedure used in obtaining furnace heat transfer rates. Work done by various researchers in this field prior to 1935 was reviewed in several papers presented before the American Society of Mechanical Engineers. (1, 2, 3, 4,)*

Professor Mullikin is well qualified to discuss this subject. He was graduated from Baltimore Polytechnic Institute and Johns Hopkins University and is the recipient of graduate degrees, including Ph. D. at Yale. He spent a year with General Electric Co. on mercury boiler development. For many years he was analytical engineer with the Babcock & Wilcox Co., engaged in heat transfer and boiler development. He was mechanical engineer with Ebasco Services Incorporated and has taught at the Illinois Institute of Technology. At present he is head of the Department of Mechanical Engineering at Montana State College at Bozeman, Montana.

*Numbers in parentheses correspond to similarly numbered references at the end of this article

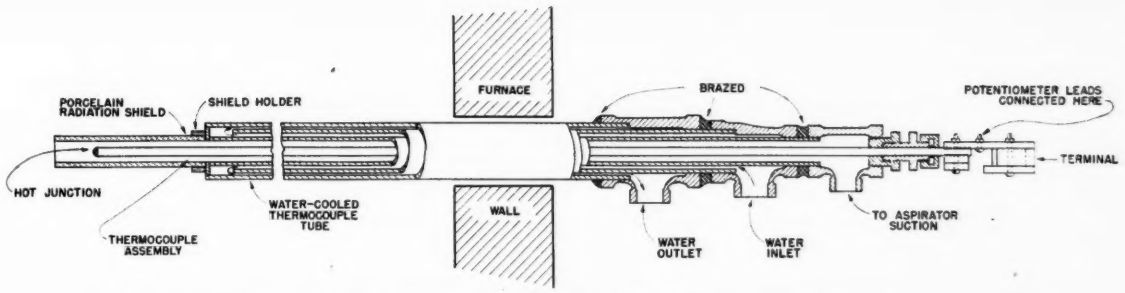

Fig. 1 Water-cooled high velocity thermocouple (HVT) developed and recommended for rugged general-service use

thermocouple will read lower than the true gas temperature. This error pointed out long ago, but (5) only recently has it been sufficiently recognized as a source of error.

High Velocity Thermocouple

The errors inherent in the ordinary thermocouple led to the development of the high velocity thermocouple (6). In the high velocity thermocouple, (HVT), the gas is caused to flow at high velocity across the thermocouple hot junction by means of an aspirator pump. One design of water-cooled high velocity thermocouple is shown in Fig. 1. The fire-end of this HVT is shown in Fig. 2. It has a single radiation shield around the thermocouple hot junction, the purpose of which is to minimize radiation from the thermocouple hot junction to surrounding cooler surfaces. This construction is suitable for use in pulverized-coal-fired furnaces where the gases whose temperature is being measured contain slag.

A more accurate-multiple-shielded high velocity thermocouple (MHVT) fire-end as shown by Fig. 3, has been developed and tested. The fire-end of this device has a number of radiation shields which further minimize the radiation error. This construction is not suitable for routine testing as the small passes plug up rapidly and the thermocouple wires must be calibrated after every few readings. The HVT of Fig. 2 may be used in routine testing and the readings corrected to a MHVT basis by corrections obtained by occasionally using the MHVT shown in Fig. 3 at the same time as the HVT; or the general correction curve of Fig. 5, later discussed, may be used. Detailed tests reported before the American Institute of Physics (8) indicated that the HVT, while not as accurate as the MHVT, was much more accurate than an ordinary thermocouple. These tests further indicated that MHVT temperatures are very close to the true gas temperature.

In the course of these laboratory tests, readings were taken by various types of pyrometers and thermocouples in a small square water-cooled duct. These readings are indicated by Fig. 4. The readings of various sizes of ordinary bare thermocouples made up of smaller size wire are more accurate than those made up of larger size wire although in all cases the bare thermocouple temperatures were below the corresponding HVT and MHVT temperatures.

These laboratory test results were verified by tests run on numerous boilers in the field. Results are summarized by Fig. 5 which shows the relation indicated by various types of temperature pyrometers. These curves represent averages of hundreds of readings taken from more than 20 steam-boiler tests, plus data from other sources.

The boilers on which test data were obtained were mostly pulverized-coal-fired units of widely different designs, but data from oil-fired, stoker-fired and gas-fired units are also included. No consistent relation between mode of firing and pyrometer temperature was found.

As previously noted, since the HVT appeared to yield the most accurate readings next in order to the MHVT, which cannot be satisfactorily used for routine work in slag-bearing gases, all corrections have been related to the HVT as a base. The correction values given by Fig. 5 are the values to add or subtract from the HVT temperature

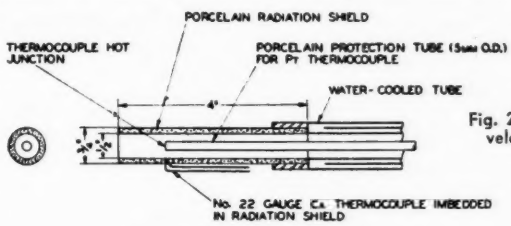
PORCELAIN RADIATION SHIELD
THERMOCOUPLE HOT JUNCTION
PORCELAIN PROTECTION TUBE (5mm O.D.) FOR Pt THERMOCOUPLE
WATER-COOLED TUBE
4"
No. 22 GAUGE Cr THERMOCOUPLE IMBEDDED IN RADIATION SHIELD

Fig. 2 Detail of fire-end of high velocity thermocouple (HVT)

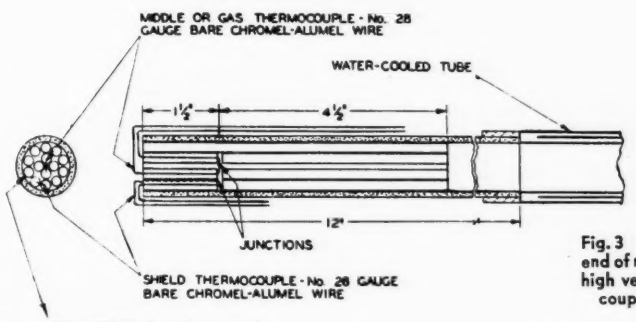
MIDDLE OR GAS THERMOCOUPLE - No. 28 GAUGE BARE CHROMEL-ALUMEL WIRE
WATER-COOLED TUBE
1½"
4½"
12"
JUNCTIONS
SHIELD THERMOCOUPLE - No. 28 GAUGE BARE CHROMEL-ALUMEL WIRE
SMALL TUBES - 5mm O.D. x 4mm I.D.

Fig. 3 Detail of fire-end of multiple-shield high velocity thermocouple (MHVT)

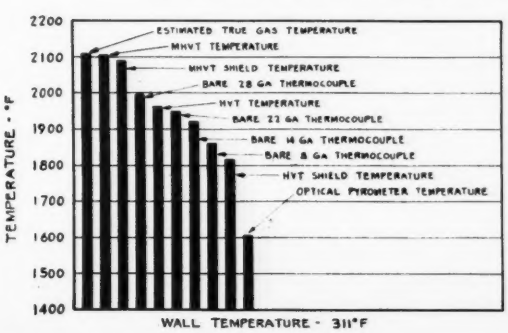

Fig. 4 Typical comparative readings of different types of thermocouples in a four-inch square duct. HVT denotes a single-shield high velocity thermocouple.

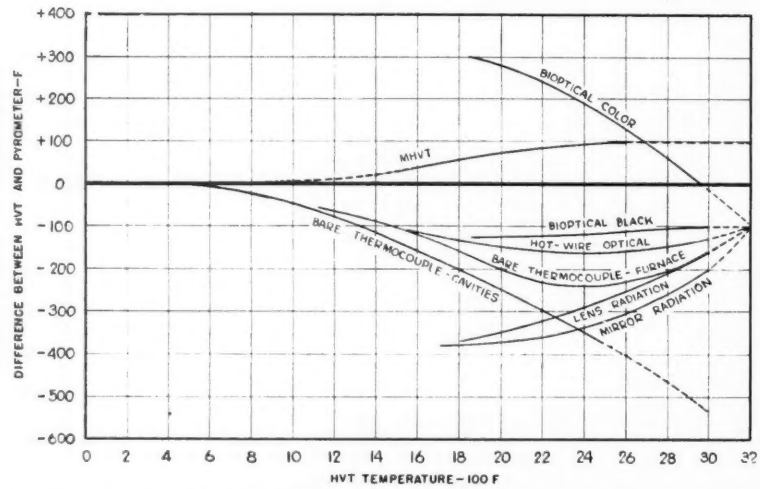

Fig. 5 Comparison of temperature indications of various types of pyrometers in gases in steam boilers. HVT denotes single-shield high velocity thermocouple. MHVT denotes multiple-shield velocity thermocouple. Readings corrected to the MHVT basis may be assumed to be true temperatures

to obtain the equivalent temperature reading of any other type of pyrometer. By adding to the HVT reading the correction to a MHVT basis given in the figure a temperature, denoted as MHVT temperature and substantially equal to the true gas temperature, is obtained.

Several kinds of pyrometers are represented in Fig. 5. One is the color-brightness "bioptical" pyrometer which gives two readings, one known as the color temperature and one known as the black-body temperature. Two different classes of radiation pyrometers are included, one of the "lens" type, in which a lens focuses the heat rays on the sensitive element, and the other a "mirror" type in which a metal mirror is used to reflect and focus rays on the sensitive element. The ordinary hot-wire filament optical pyrometer and bare thermocouple are also represented, the bare-thermocouple results being applicable for 22-gage-wire size and larger (due to accumulation of slag on the wire).

In Fig. 5 a distinction is made in the case of ordinary thermocouples between a "furnace," either primary or secondary, and a "cavity" such as occurs between tube banks. Small radiant passes such as are found in open-pass types of boilers may be classified as cavities. Different curves are given for bare thermocouple temperatures, depending on whether the measurement is made in a boiler furnace or in a cavity. The "cavity" bare-thermocouple plot is also applicable with less accuracy to measurements made between tubes (intertube). For types of pyrometers other than ordinary thermocouples no distinction is made between furnaces and cavities.

The optical, radiation, etc. pyrometer curves are applicable to both furnaces and "cavities," but ordinarily not between closely-spaced tubes. The bioptical color temperature apparently reads appreciably above the MHVT or true gas temperature. This is presumably because this instrument is calibrated for the purpose of reading the temperatures of molten metals rather than of layers of gas or flame.

The dotted lines in Fig. 5 represent extrapolated and estimated values, there being little data above 3000 F. Based on the apparent slope of the curves it would appear that in steam-boiler furnaces most of the temperature-measuring devices will read about the same at 3200 F.

These plots give an average correction between readings obtained by the given pyrometers. Individual determinations will vary from the corrections given by plus or minus as much as 200 F, but the average correction of a large number of readings may be expected to lie fairly close to the values given.

The plots give relations to be expected under average conditions. Where readings are taken under unfavorable conditions adjustment should be made. Thus an optical pyrometer, used to obtain the gas temperature of a clear gas in a very small cavity surrounded by clean cold surface, may be expected to read low. Similarly the optical pyrometer will read high if sighted on the center of the flames issuing from a burner, when viewed from an opening near the furnace outlet. Similarly a bare thermocouple reading in a well-cooled ash-pit through which little or no gas is passing will read high. These are abnormal conditions. Readings obtained under normal conditions are represented by the plots.

Although necessarily inaccurate, it seems advisable to use these empirical corrections to a MHVT or

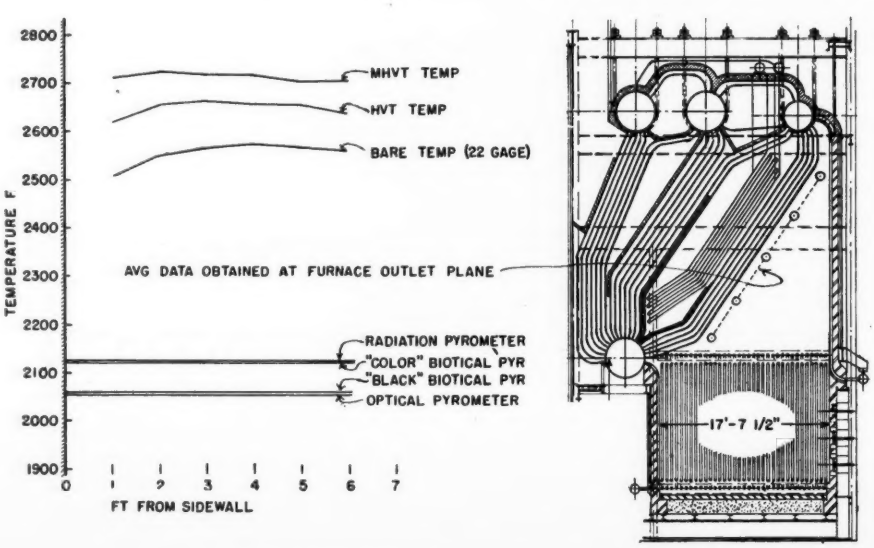

Fig. 6 Comparative data obtained by different types of pyrometers at the furnace outlet of a natural-gas-fired boiler furnace. HVT denotes single-shield high velocity thermocouple. MHVT denotes multiple-shield high velocity thermocouple. Bare thermocouple is that indicated by an exposed bare thermocouple of 22-gage wire

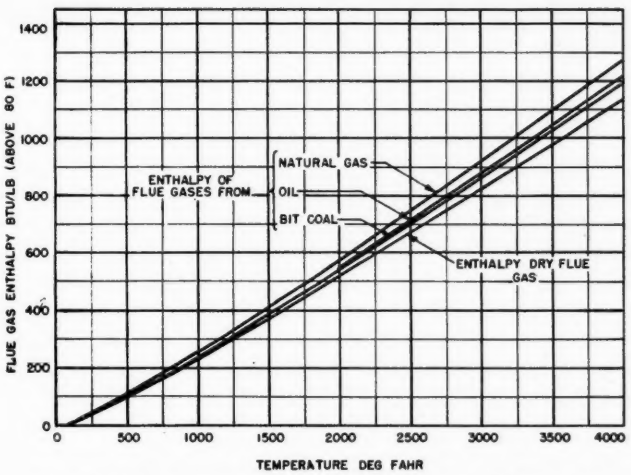

Fig. 7 Enthalpy-temperature curves for flue gases. Enthalpy is also known as heat content, heat capacity or sensible heat. The enthalpy values are in Btu. per lb. above 80 F. If the per cent water vapor is known then the enthalpy for any flue gas may be found by multiplying enthalpy values for dry flue gas by (100 plus % water vapor ÷ 100)

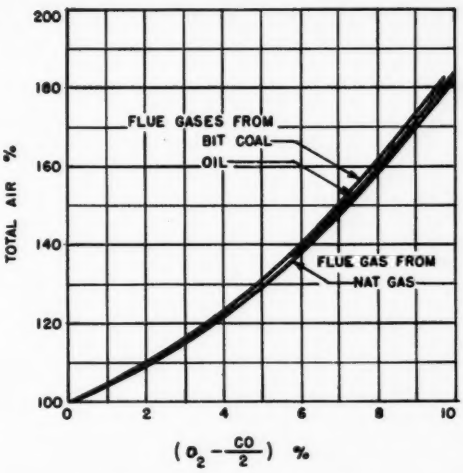

Fig. 8 Total air versus oxygen curves for typical fuel flue gases. Total air % equals 100% plus excess air %

true-temperature basis rather than to use the as-read values without any correction whatever. Actually, no general curves can ever be given to fit other than very special cases. In any given installation, accurate values must be obtained by test. Curves given for general conditions, such as the above must be more or less inaccurate.

It should be understood that where it is not possible to use the MHVT, which is the general case, use of the HVT rather than any other of the pyrometers is recommended as being more accurate and involving smaller corrections to a MHVT basis.

Figure 6 illustrates the type of data obtained on an actual boiler installation that was used to establish Fig. 5. It shows gas-temperature readings obtained from a natural-gas-fired Stirling boiler. The temperature of the gas entering the tube bank, taken with a MHVT averages 2715 F. The HVT gives about 2650 F and the bare thermocouple about 2560 F.

Those interested in the details of construction and operation of the high velocity thermocouple (as well as 25 other methods of gas temperature measurement), should refer to the author's chapter in "Temperature" (7), a book containing much information on temperature measurement and control in science and in industry. An early short magazine article (6) may be more available to some.

Specific Heats

In boiler and furnace calculations it is necessary to use certain specific-heat and excess-air properties of flue gases. Attention is called to modern concepts familiar to boiler designers but which have not yet been reached by the text books.

The older specific heats have been superseded by newer specific heats based on spectroscopic data first summarized by Justi in 1938 (10) and later publicized by Heck in *Mechanical Engineering (11)*.

Available data indicate that dry furnace flue gases average 22 per cent excess air corresponding to 15.5% CO_2, 3.9% O_2, and 80.6% N_2 on a volumetric basis. Using this heat content at constant pressure a analysis a plot can be made for the heat content at constant pressure (a quantity now called enthalpy) in Btu per lb of dry flue gas, versus temperature. This is shown on Fig. 7.

Due to the fact that for wide ranges of fuels and excess air, dry flue gases still remain essentially 80 per cent nitrogen, this curve may be used for all normal dry flue gases with an error less than one percent.

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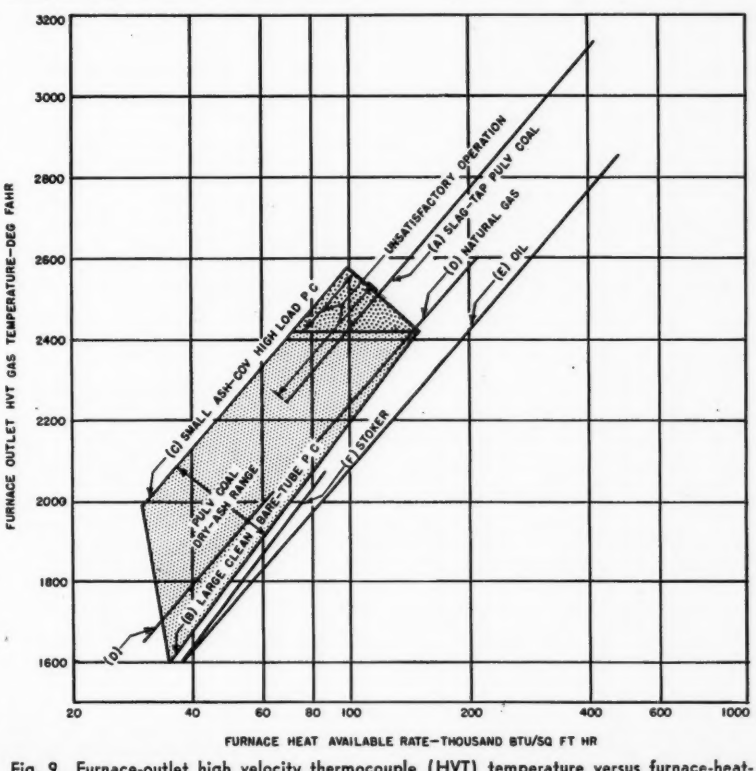


Fig. 9 Furnace-outlet high velocity thermocouple (HVT) temperature versus furnace-heat-available rate for water-cooled furnaces. To correct HVT temperature to the most accurate (true) temperature use the HVT to MHVT correction given in Fig. 5

Trenton Channel Adds 200,000 Kw

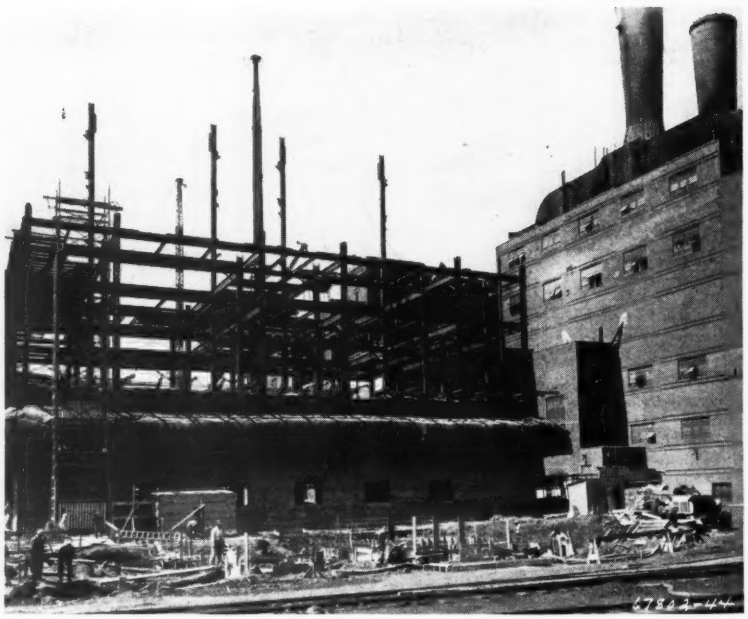


Fig. 1. Status of construction work, as of April 8, 1948, on the new extension of Trenton Channel to house two new 100,000-kw, 1300 psi, 950 F turbine generator units

AT THE FAMOUS Trenton Channel Station of The Detroit Edison Co., work is now going ahead rapidly on an extension to the plant, which will include two new steam turbine generators each with a nominal capacity of 100,000 kw, to be supplied with steam at 1300 psi, 950 F by four steam generating units each capable of producing 600,000 lb of steam per hr.

It will take approximately two years more to complete this extension, raising Trenton Channel's present 300,000-kw capacity to the half million mark and increasing the capacity of the Detroit Edison system more than 15 per cent.

Work on the extension began on July 2, 1947. The condenser circulating water ducts and the substructures for the boiler house and the turbine house are finished. Boiler house steel was scheduled for completion in June 1948. By October 1948, floors, walls and roows should be finished and erection of boilers and turbines should begin. It is planned that two of the four boilers and one of the turbine generators should be ready by August 1, 1949. The third boiler is scheduled for completion one month later and all the work should be done by May 1, 1950. The new extension will be a major factor in the plans of The Detroit Edison Co. for carrying its rapidly growing load.

New Steam Generating Units

The general cross-section through the boiler plant for the new 200,000-kw extension is shown in Fig. 4. The four new boilers, to be supplied by Combustion Engineering Co., will be high pressure units in contrast to the low-pressure boilers now installed in the main Trenton Channel plant. They will be fired by pulverized coal, supplied by three vertically-adjustable tangential burners in each of the four corners of each furnace. Provisions for burning fuel oil will also be incorporated by installing two oil nozzles per burner between the three coal nozzles of each burner.

The boiler units, Fig. 6, are of the three-drum type, with three-bank superheaters, integral finned-tube economizers in the rear pass, and regenerative rotary-element type air preheaters following the economizer surface. The furnaces are fully water cooled, using closely-spaced plain tubes. They are of the basket bottom type discharging to a sluicing hopper.

Pulverized coal will be supplied by an extension of the existing pulverized coal system, which is of the storage type and in which new pulverizers are being installed for the increased capacity. The vertically-adjustable tangential burners, in conjunction with Montaup type by-pass dampers, are designed to provide accurate regulation of total steam temperature.

Combustion air will be drawn by the forced draft fans from either inside or outside the plant through ducts, depending upon the weather. Flue gas will pass through a Cottrell electrostatic precipitator on each boiler after it leaves the air preheater and before it flows to the induced draft fan for discharge to the stack. The new electrostatic precipitators, designed to remove 95 per cent of the fly-ash, will be similar in principle to those in use now at Trenton Channel, which were among the first to be installed in large central power stations. The fly-ash and flue dust will be disposed of according to the methods described in the article, Stack Dust Collection and Disposal by P. W. Thompson, POWER PLANT ENGINEERING, October 1947. To facilitate these methods, a new flue dust loading house will be erected just East of the new boiler house extension, Figs. 3 and 5.

The two new turbine generator units, to be supplied by General Electric Co., will be of the type shown in Fig. 2. They will be tandem compound with a double-flow, low-pressure section. The high-pressure turbines are of the single-flow design with five bleed points for feedwater heating at the 7th, 10th, 13th, 16th and 19th stages. Final feed temperature will approximate 430 F.

The high-pressure turbine ex-

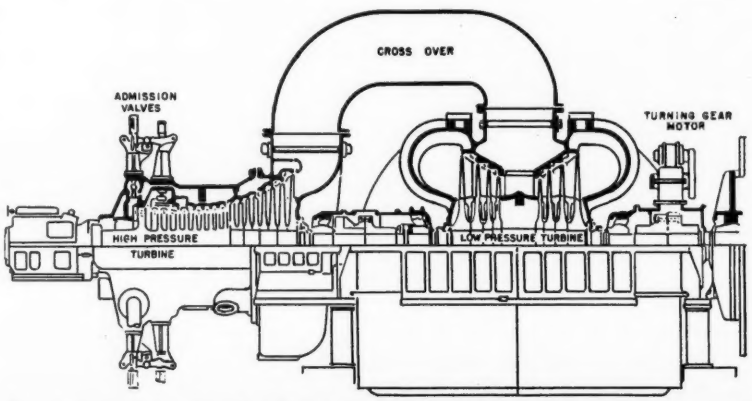


Fig. 2. Cross-section through tandem-compound General Electric turbine of the type to be installed at Trenton Channel

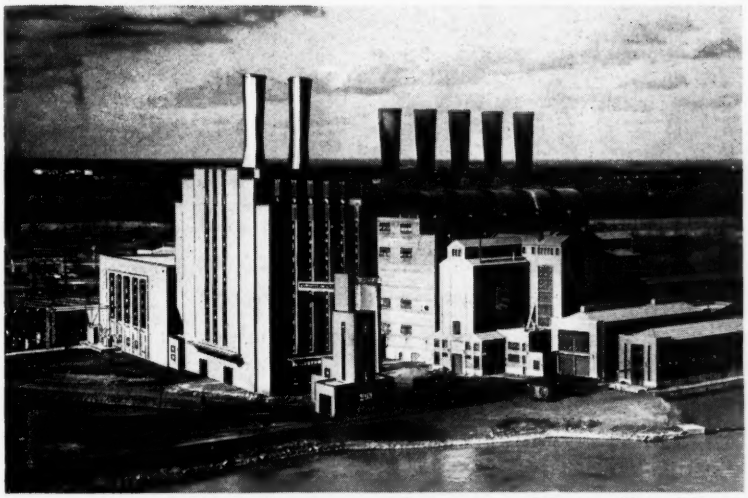


Fig. 3. Architects drawing showing the expected appearance of Trenton Channel Station after the new 200,000-kw extension has been completed

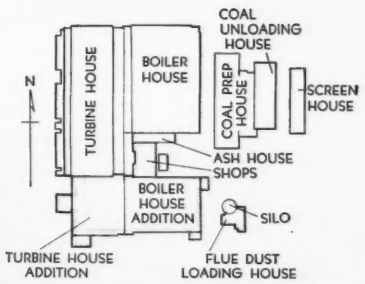


Fig. 5. General plan of Trenton Channel showing relation of extension to existing station, new shop building and new flue dust loading house

hausts at approximately 8 psi absolute through the cross-over pipe to the low-pressure turbine and since the cross-over pressure of these units will always be below atmospheric, gland leak-off from the low-pressure end of the high-pressure turbine and from the low-pressure turbine is eliminated.

Preliminary heat balance data show that at a throttle flow of 800,000 lb per hr and a generator output of 100,130 kw, the turbine heat rate will be 8,524 Btu per kw hr and the steam rate will be 7.990 lb per kw hr.

Instead of atmospheric relief valves on these units a vacuum breaker and blow-out disks will be provided in the exhaust hood. The generator, which will be hydrogen cooled, is the first with this type of cooling system to be used by Detroit Edison. The generator is rated at 125,000 kva, 0.8 pf, 15,500 v, 1800 rpm.

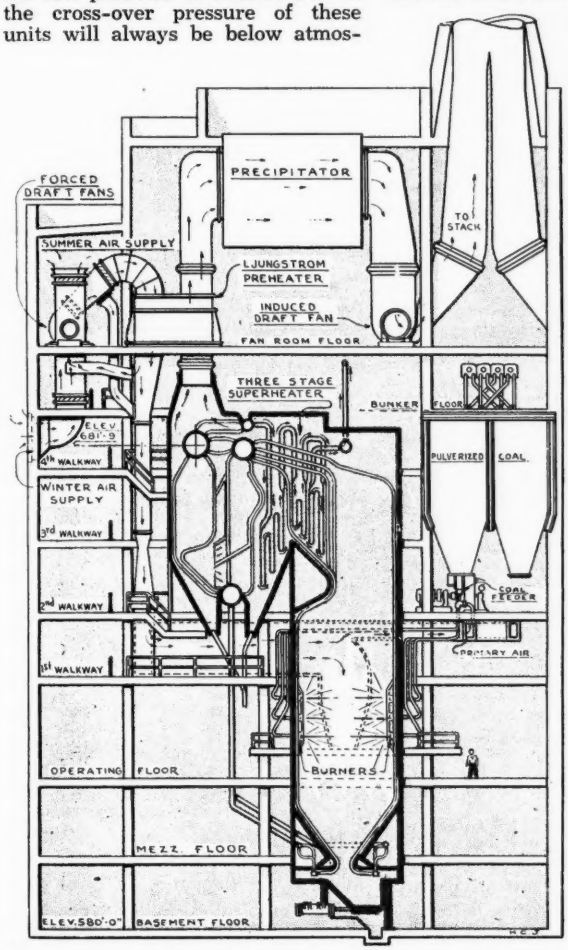


Fig. 4. General cross-section through new boiler house section of Trenton Channel extension, showing outline of one 600,000-lb-per-hr steam generating units, fired by pulverized coal from the existing pulverized coal storage and preparation system; location of forced and induced draft fans, air preheater and electrostatic precipitator

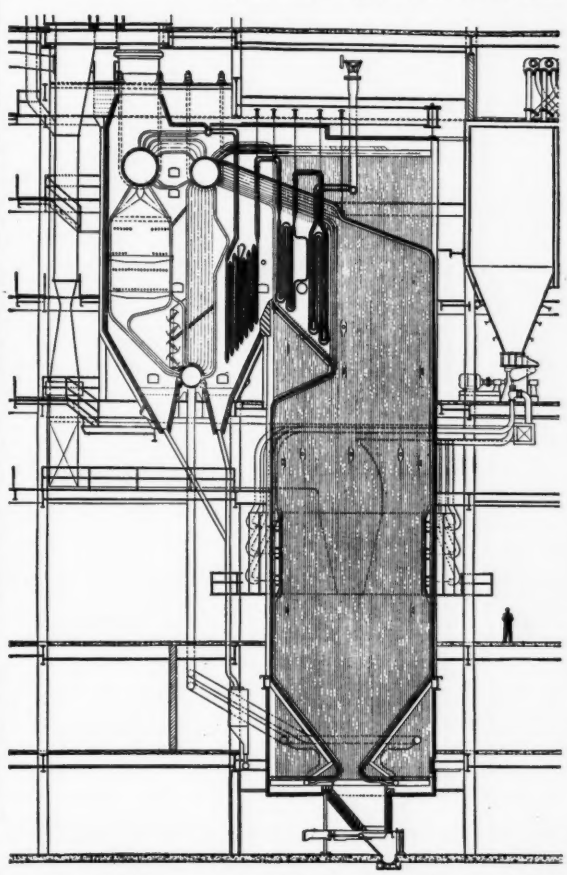


Fig. 6. Detailed cross-section through one of the new 600,000 lb-per-hr, 1300-psi, 950F pulverized-coal-fired steam generating units for Trenton Channel

ATOMICS

A New Section added to POWER GENERATION to cover current and forthcoming developments in atomic energy and related developments and applications in Nuclear Physics

How Far Away is Atomic Power?

Many people are trying to answer this question but unfortunately their answers depend upon how the development of atomic energy will affect their personal interests. No one, of course, can answer the question with any degree of accuracy but as indicated in this article it is not wise to let one's selfish interest blind one's judgment in regard to the future of atomic energy. Things happen fast these days and the practical development of atomic power may be much closer than some people would like to believe

By **ANDREW W. KRAMER**, Editor, Power Generation

ONE'S FAITH or enthusiasm in the future of atomic energy, it seems, is inversely proportional to the intimacy of one's interest or association with the application of other forms or sources of energy. Most physicists, who have no commercial axes to grind, are highly enthusiastic over the possibilities of atomic power though their predictions may be tempered by customary scientific caution. Engineers as a class, particularly those concerned with the commercial production of power, are less enthusiastic about its immediate adoption but they are definitely interested in learning more about it. Coal and oil men, on the other hand, are quite "agin" it—they see little hope of its early adoption.

All this, of course, is quite natural. It is to be expected that one would endeavor to protect one's own interests from competition with something new. It is, however, not quite fair for individuals with selfish motives to influence and mislead the public at large in regard to what is, and what is not, possible in the development of atomic energy.

Speaking before a group of power sales engineers recently, a representative of a prominent coal company[1] implied that the commercial development of atomic energy was much farther away than many atomic scientists have indicated. In support of this contention, he made a number of statements which, if they are not altogether untrue, are certainly open to argument. For example, he said, "It is one thing to let go an explosive force which can obliterate an entire city in a flash. It is quite another thing to learn how to control such a tremendous energy force, so that this energy is slowed down to become a useful work horse over a long period of time. Most familiar energy origins—coal, wood, petroleum, wind, sunshine, can be controlled with precision. *Until atomic energy can be similarly controlled,* we'll continue to utilize our familiar and easily available energy sources. It will probably be many years until atomic energy is tame enough to be used for ordinary needs." (The italics are ours).

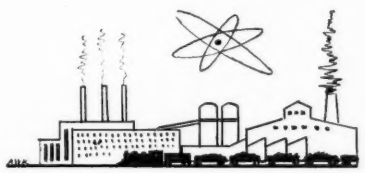
In quoting this speaker's remarks, the point I want to make clear is this; Atomic energy *can,* and *is* being controlled with precision—with infinitely greater precision than the combustion of coal in a boiler furnace. One has only to read the Smyth Report to learn that in their work under the Manhattan District, the scientists and engineers achieved a controlled nuclear reaction long before they knew how to bring about the uncontrolled nuclear reaction of the atomic bomb. Indeed, when the first self-sustaining chain reacting pile at the University of Chicago went into operation on December 2, 1942, the first time that human beings ever initiated a self-maintaining nuclear chain reaction, the pile was operated at a power level of ½ watt!

Imagine the delicacy of the control that would enable this pile to operate at the very low power level of ½ watt! Could the combustion of coal be controlled within such narrow limits?

Later on in the work of the Manhattan District when the decision to construct the huge nuclear chain reacting piles at Hanford was made, the proposed use of a cylindrical lattice of uranium rods imbedded in graphite moderator was dictated primarily by engineering considerations. It was evidently more convenient to cool a rod with a flowing

[1] It is unfortunate that his name and company cannot be mentioned but the meeting at which he delivered this address was a closed meeting and we cannot violate the rules under which we, as editors, were permitted to attend.

film of water than it is a sphere or a plane. Once this decision was made, it meant that all theoretical calculations of the multplicative properties of the system, the neutron distributions, and so on, involved cylindrical functions. The solutions of the problem of neutron distribution, therefore, involved Bessel functions of a certain range not found in the British Association Tables. In order to avoid the necessity for laborious interpolation in the British Association Tables when neutron distributions in graphite were needed,



it was felt advisable to have a table of Bessel functions which would fit the problems at hand and so the Computation Laboratory operated by the National Bureau of Standards compiled the necessary special tables for the atomic scientists.

The only point in mentioning these tables is to re-emphasize the fact that nuclear fission can be controlled and calculated with a precision so much greater than the combustion of coal that special mathematical tables had to be compiled to make the calculations.

However far away may be the practical development of atomic power plants, no one can truthfully say that atomic energy cannot be controlled with precision. It can, and is, being controlled every day both at Oak Ridge and at Hanford.

When will we have Atomic Power?

With regard to the time that may elapse until we utilize nuclear energy for practical purposes, as has been indicated in these pages in previous articles, that is dependent upon how soon we want it—upon how much money and effort we are willing to spend on it. Given, several billions of dollars and the required national approval, we could have nuclear energy power plants in operation in competition with coal and oil in a matter of ten years, perhaps less.

The same speaker referred to in the foregoing paragraphs also quoted Dr. Oppenheimer as saying that the use of atomic energy in any substantial quantity to supplement existing power resources is unlikely to come before 30 to 50 years but that demonstration plants might come within five years. Commenting on Dr. Oppenheimer's reference to demonstration plants, the speaker cited the first demonstration airplane in 1903 and the many years that passed before the airplane began to affect our daily lives. He also referred to the long interval of time between Marconi's first demonstration of wireless telegraphy and the use of radio by the common man. As a matter of fact, especially in view of the limited facilities for scientific research, both the airplane and radio developed very rapidly. Between the Wright Brothers flights at Kitty Hawk and the first nonstop airplane crossing of the Atlantic (Alcock and Brown's flight in 1919) there was an interval of only 16 years.

With respect to radio, Marconi demonstrated his system of wireless telegraphy in the summer of 1895 and only two years later, in July 1897 a company was formed in London to acquire the Marconi patents in all countries except in Italy. In 1901, only six years after his first demonstration, he succeeded in transmitting wireless signals across the Atlantic!

Use Manhattan District As a Yardstick

Is six years a long time? True, radio broadcasting did not come into commercial being until 1921 but even that event occurred only about 25 years after Marconi first showed that electric waves could be sent over considerable distances. Today, we live in a much faster-moving world. Remember, it was only seven years from the demonstration of nuclear fission by Hahn and Strassman in Germany to the dropping of the atomic bombs on Hiroshima and Nagasaki. In the development of the atomic bomb a hundred years of research and development was crowded into a period of about 5 years. The development was carried on under the impetus of war but it showed what modern scientific effort could do under proper stimulus and in forming our opinions on what is possible and what is not possible in the development of atomic power we should use the Manhattan District as the basis of measurement, not our rate of progress in a less scientific era. It is all well and good to be enthusiastic about coal and oil both as a fuel and as a source of raw material for the manufacture of valuable products but we should not let such enthusiasm blind us regarding the possibilities of an entirely new source of energy many millions of times more powerful than anything we have ever known.

Few people outside the scientific world really know how much is being done in atomic research these days. In articles in this section I have described some of the more spectacular developments—progress in high energy physics, what is being done in the construction of high voltage accelerating equipment, but it is impossible to even mention all the complex experimental work of a less spectacular nature that is going on in our laboratories all the

ATOMICS

time. Every issue of the Bulletin of the American Physical Society for example contains descriptions of dozens of researches in nuclear physics. Some of them are of minor importance but each one contributes a little more to the mass of steadily accumulating data which some day will be translated into practical accomplishments. If no atomic bombs are being exploded do not assume that research in nuclear physics lies dormant. If it were the U.S. Atomic Energy Commission would not be financing the construction of a new 9 million dollar cyclotron at the University of California or a new multi-billion electron volt synchrotron costing 3 million dollars at Brookhaven Laboratory.

So it is unwise for the coal and oil men and others commercially concerned with conventional power sources to underestimate the potentialities of nuclear research. Things may happen faster than they would like to believe. True, atomic energy power plants may not be able to compete commercially with coal and oil burning plants for some time after they have been developed but that does not mean that ultimately they will not be able to compete. While estimates have been made as to comparative costs of coal-fired power plants and nuclear energy power plants at the present time such estimates are unreliable either way. In the ultimate analysis the problem of atomic energy vs coal or oil may have to be considered not so much from the standpoint of costs as from that of conservation. Continued development in chemistry may make coal and oil commodities entirely too valuable to be burned under boilers.

Military Anxious to Have Atomic Power

One significant factor is of particular interest in this consideration of the development of nuclear power and that is that despite the great emphasis upon atomic weapons, the Atomic Energy Commission is under considerable pressure to put more zip into its power development program. Curiously, the strongest pressure is coming from the military. AEC's underlying attitude at present is that it owes complete priority to production of more and better

(Continued on page 100)

The PRACTICAL ENGINEER

DEVOTED TO PLANT OPERATION and MAINTENANCE

A. W. KRAMER, EDITOR

Why Keep Boiler Room Logs?

While the log sheet is usually regarded as one of the necessary evils in the life of the average operating engineer, it is actually one of the best safety devices in the power plant. The experience described in this article forcefully illustrates how the routine, periodic reading and recording of each instrument insures protection against any unusual operating condition

By K. H. MACK

WHY SHOULD it be necessary to read the recording and indicating instruments of the control board every half hour or every hour and why should the readings be put down in a log? Is it only to keep the boiler operators on their toes? Does any one read the log? Did management devise this chore simply to make the life of a boiler operator more miserable than it already is?

The casual visitor to the average boiler plant often hears comments of this nature. The boiler operator is puzzled. He cannot see the sense of duplicating what recording boiler charts do better and more accurately. When a man has been given a job to do, and the reason for and purpose of this work has not been explained to him, there is good justification for his criticism of his boss.

Reading of boiler instruments and making a record of the readings every half hour or every hour by a competent boiler operator is one of the best safety devices in the power plant. However, the operator must understand that the log is not kept primarily for the benefit and education of some one in the front office, or as a means of checking whether or not the men are on the job, but that routine, periodic reading and recording of each boiler room instrument insure that any unusual boiler operating condition is quickly detected. Conditions which may lead up to trouble can be found and corrected before they have reached dangerous proportions.

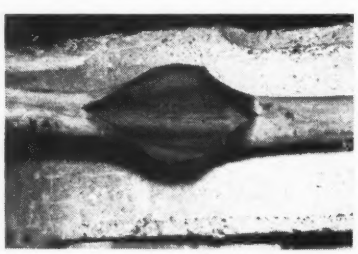


Fig. 1. The force of the explosion was so terrific that the tube split wide open and other side wall tubes in the vicinity were thrown out of alignment

A recent experience in the power plant of a large industrial concern serves as a good illustration of what can happen where reading of boiler room instruments is left purely to chance and to the inclination of the men in charge. It is an old story that one becomes so used to the sight of familiar objects with which one is surrounded in every day life that they lose all appeal to one's senses.

The Instrument Board was Taken for Granted

The power plant in question is equipped with the most complete and well designed control board with instruments recording steam flow, feedwater flow, steam temperature, feedwater temperature, temperatures of combustion gas and air. Until very recently the instrument board might not have been in existence if it had not been for the benefits derived from it. It became one of the familiar objects in the life of the operating engineers and was taken for granted; it was given very little attention. The recording charts were conscientiously replaced every 24 hours and carefully filed away.

The power plant contains two large modern pulverized coal fired boilers. Both are needed during a normal production day to furnish steam to turbine generators and for process. During the night period, with part of the manufacturing plant shut down, only one boiler is required to supply the necessary steam. The second boiler is kept "under bank," which means pulverizers and burners are shut down and fans are stopped, but the boiler is kept hot so that only 10 to 15 minutes of continuous firing is required to raise the pressure and bring the boiler on the line in the morning.

The feedwater for both boilers is supplied by one common header with feed line branches containing the usual automatic feedwater regulating valves going to each boiler. Each branch is equipped with a manually operated shut-off valve in addition to the usual feed line valves. It was found necessary that the hand shut-off valve be closed while the boiler is under bank because the automatic feedwater regulating valve would not seat sufficiently tight to prevent feedwater from entering the idle boiler. It was therefore the duty of one of the operators as a matter of routine to tightly close the feed line shut-off valve in the evening and to open it next morning on resumption of operation of the banked boiler.

One day, one of the side water wall tubes exploded, just about three hours after the boiler had been placed on the line following an overnight bank. The tube split wide open (Fig. 1) with such force that other side wall tubes in its vicinity were

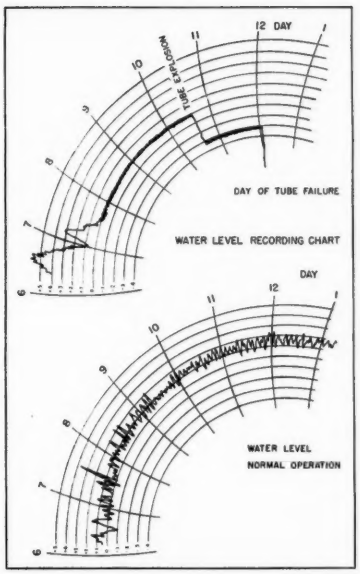


Fig. 2. Below: Jagged water level line usually drawn during normal operating day. Above: Smooth line drawn for the period preceding the tube explosion

kicked out of alignment. Fortunately, the boiler unit is completely enclosed in a strong steel-cased setting so that the damage done by the explosion was confined to the boiler furnace. The boiler was forced off the line but the second boiler was able to take over the load dropped by the first one so that the steam and power supply to the manufacturing plant was not affected, and serious production losses were prevented.

The investigation, which was started immediately after the excitement had died down, brought to light a number of interesting clues, although it was only after the investigation had progressed for quite some time before the mystery of the tube failure was explained. The boiler had served faithfully for several years. There was never any indication of circulation difficulty in boiler or water wall tubes. The steam load prior to the tube explosion was quite low. Firing rates and furnace temperatures were low, the burners were correctly adjusted, there was no flame impingement on wall tubes and yet the first cursory inspection left no doubt that the tube failed because it had overheated and had apparently not received its share of water.

The possibility that one end of the tube had become accidentally plugged was considered. It was argued that while the boiler was standing idle overnight much of the suspended boiler water solids would gradually sink to the lowest point of the pressure system and would accumulate in boiler water wall headers. It would be possible for the accumulation to build up high enough to partly close the entrance to side wall tubes so that water supply to the tubes would be impaired. However, internal inspection of bottom headers showed no trace of deposits. This in itself was not taken as conclusive evidence that solids had not been in the header prior to the explosion. The tremendous shock of the pressure system produced by the explosion could have dislodged whatever sediment there was in the headers and the rapid draining of the boiler which followed would have removed it.

Although the tube had opened at an elevation about 20 ft below the normal water level of the boiler so that all water contained in the boiler above the point of tube failure drained into the furnace and through the furnace floor onto the boiler room floor, there was surprisingly little flooding.

Nothing Unusual Prior to Accident

The boiler operator in charge was quite emphatic that he could see nothing unusual in the performance of the boiler prior to the accident. It is true that he had not looked at the instrument board. It was also admitted that the high and low water alarm whistles of the water columns were blowing but the operators were so used to hearing the whistles blow that they placed no significance in their blowing. The whistles were stuck before and they probably were stuck again. The shift engineer had given one glance at the water level recorded and found that the boiler water level was where it should be.

Recording Charts Tell the Story

The recording chart, shown in Fig. 2, did show that the water level was maintained on the zero line, which represented normal level for the

PRACTICAL ENGINEER SECTION

boiler. However, comparing the chart with the one of the day before disclosed that the level recorded prior to the tube failure was suspiciously steady, whereas normally a saw-tooth water level line is drawn. Inspection of the recording instrument disclosed that a speck of dirt had lodged between two electrical contact points and fixed the recording pen at one point. This produced the smooth line shown for the operating period preceding the tube explosion.

The water tender, who was entrusted with opening the feed branch valve, was sure that he had opened the valve wide while the boiler was made ready for operation. He could not explain why the feed valve was found to be only cracked, but he did reckon that he might have been distracted while he was in the process of opening the valve. Incidentally the water tender is a native of Brooklyn and the accident happened on one of the days the World's Series was being played off.

The feedwater flow meter recorder left no doubt that the rate of water fed into the boiler was less than the rate of steam taken out of the boiler. The recording chart, Fig. 3, shows that the boiler was fed at the rate of less than 30,000 lb per hour, whereas the steam flow chart showed the boiler delivering 50,000 lb of steam per hour.

The evidence so far presented clearly pointed to the cause for the tube failure; it was simply low water. In fact, a subsequent internal inspection of the boiler unit dis-

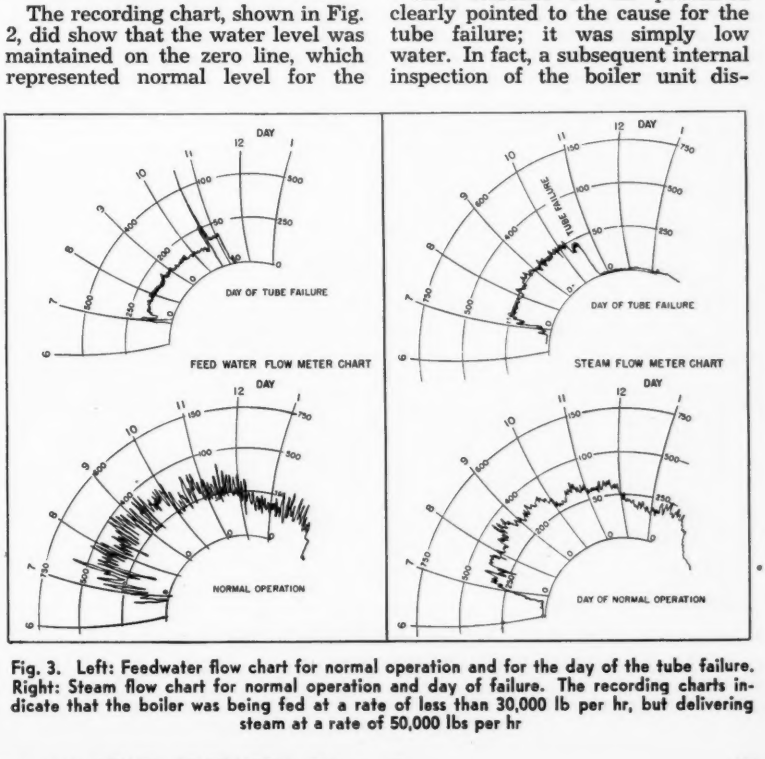


Fig. 3. Left: Feedwater flow chart for normal operation and for the day of the tube failure. Right: Steam flow chart for normal operation and day of failure. The recording charts indicate that the boiler was being fed at a rate of less than 30,000 lb per hr, but delivering steam at a rate of 50,000 lbs per hr

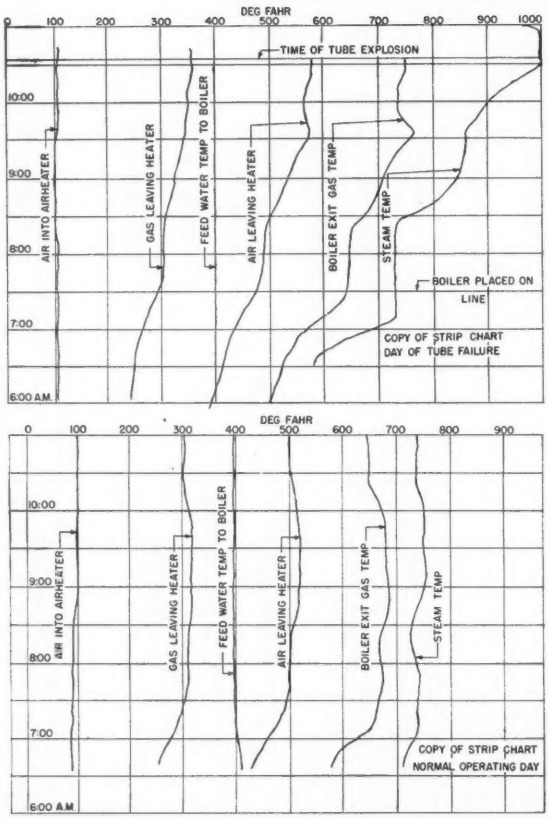


Fig. 4. Below: Temperature recording chart for normal operating day. Above: Same chart for the day of tube failure

closed that the water level had disappeared entirely from the boiler proper. Steaming tubes of the water wall system were fed from water stored in the lower drum of the boiler, but after this last source of water was used up the tube let go.

It was not necessary for the determination of the cause of the trouble to obtain the additional evidence presented by the temperature recording chart, but it helped to round out the story. Air and gas temperatures, feedwater and steam temperatures are recorded on a strip chart. The normal steam temperature is approximately 730 F for the low steam output rate recorded for this day. The temperature recording chart of the day of the accident, Fig. 4, shows normal steam temperature between 7:10 AM, when the boiler was placed in service, until about 8:20 AM. Then the steam temperature started to rise. The steam flow meter chart recorded no change in steam output rate and the firing rate was held substantially constant, but exit gas temperatures and combustion air temperature started to rise with the steam temperature. About 10 minutes prior to the explosion the steam temperature had reached 1000 F and the recording pen was "riding" the edge of the chart.

The recorded rise in steam, air and gas temperatures could only be explained by the fact that the water level had dropped to a dangerously low point. The entire upper part of the steam generating section of boiler and water walls had, in effect, become superheater surface. Evaporating tubes were superheating the steam instead of evaporating water. Thus the rise in steam and flue gas temperatures.

With the exception of the water level recorder the boiler room instruments clearly and faithfully illustrated the conditions leading up to the accident. It may be considered inexcusable that no one took the trouble to look at the board during the two hours, or more, preceding the tube failure, but no one of the boiler house crew was specifically instructed to read the instruments. It was simply taken for granted that with the instrument board in front of everyone's eyes there would be no question about making use of what the instruments showed.

Why Log Sheets Should be Kept

Had there been the routine of reading and recording the boiler house instruments in closely spaced periods this accident would certainly have been prevented. The man reading water level, feedwater flow and temperature recording charts would certainly have questioned the unusual records shown and there would have been time to correct the condition before any damage had been done.

As a result of the accident and the investigation which followed, the routine of reading the instruments every half hour and recording the readings on a log was immediately instigated in this plant. Periodic meetings of boiler house crew and chief engineer are being held to acquaint the operators with conditions leading up to the boiler operating troubles. The practice of comparing recording charts of the preceding day with those of the current operating day has been established to familiarize the operating personnel with records which can be considered normal so that the operators will quickly recognize whatever unusual condition may be shown by the instruments.

Realizing that rise in steam temperature above normal is a good indication of low water in the boiler, an alarm device has been installed which receives its impulse from a thermostat located near the superheater outlet. Whenever the steam temperature should rise above 760 F, the alarm will sound a most annoying siren in the boiler house, loud enough to wake the dead.

One experience of the type described brings the necessity of a well kept boiler room log very forcefully to everyone's attention. Not only management and the power plant Chief, but every one down to the youngest fireman apprentice realizes that periodic reading and recording of the story shown by boiler instruments is one safe way of staying out of trouble.

A well kept boiler house log can be made to serve the personnel in gaining a clearer understanding of duties and responsibilities. The log can become especially valuable if the boiler house Chief makes the records shown the base and subject of frequent discussions with the men in his charge. These records present the reason for suggesting improvements, if necessary, and to give praise where praise is due.

WORK IN PROGRESS AT NORTHEAST PUMPING STATION, DETROIT

WORK IN progress at the Northeast Station, of the City of Detroit is on the site of a future filter plant and pumping station and will fit in to the completed scheme. At the present time under contract is a 30,000,000 gal reinforced concrete reservoir and booster station, together with the accompanying connecting pipe lines and sewers.

The booster station will have installed in it four-40 mgd electrically driven pumps, three of which have been purchased from the U.S. Government and which were formerly used in the Modern Avenue Booster Station in this city.

The cost of the work which has been let to date will be about $2,500,000 by the time the pumps are ready for operation.

The Annular Air-Flow Orifice

For measuring air flow, this orifice has been found insensitive to entry conditions . . . Does not need long run of straight pipe ahead of it and can be installed in or at the entry to a pipe system . . . Developed in British aircraft research during war*

By A. R. HOWELL

CHANGES IN THE amount and nature of the turbulence at the entrance to the usual orifice used in air flow measurement frequently exert a considerable effect on the discharge coefficient. To overcome this difficulty it is usually necessary to install a long length of straight pipe immediately upstream from the orifice. This often complicates test arrangements, and often, in practical applications, as in airplanes, makes a satisfactory installation impossible.

Accordingly, the R.A.E. annular air flow orifice shown here was developed. It consists essentially of a sharp-edged circular plate mounted co-axially inside a pipe of a rather large internal diameter, as shown in Fig. 1. The air flow is determined as a function of the pressure drop across the plate, which is measured by means of the measuring holes in the two sides of the plate, connecting through the center pipe to the pressure connections.

This orifice was tested under many different conditions, changes were made in details and various entry conditions were investigated, such as: long straight pipe ahead of orifice; right angled corners with and without swirling vanes; entry open to atmosphere. The discharge coefficient was unaffected by these changes within the limits of experimental error, ±½ per cent.

Effect of Position of Pressure-Measuring Holes:—The orifice was tested with the pressure-measuring holes at different diameters. It was found that no alteration in the discharge coefficient could be detected when these holes were changed from a pitch circle diameter of about 0.25 disk diameter to one of about 0.75 disk diameter. Normally a fairly large diameter was used for the holes.

Effect of Disk Form:—It is important that any increase in disk thickness, made necessary by the cover plates carrying the pressure measuring holes, should not be carried to such a large diameter that it interferes with the flow past the annulus. In the orifice shown in Fig. 1, the arrangement is such that no thickening is required. There is no evidence that the disk thickness affects the discharge coefficient, but it is recommended that the values used in these tests should be adhered to; namely, a disk in which the thickness is 6 per cent of the disk diameter.

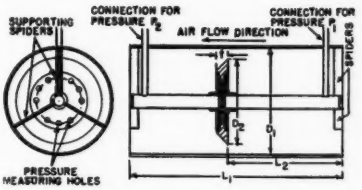


Fig. 1. Diagram showing construction of R.A.E. annular air-flow orifice

Effect of Annulus Width:—The orifice was tested with annuli of different widths. It was found that the effect on the discharge coefficient of altering the ratio of disk diameter to pipe internal diameter from 0.70 to 0.90 was small, as is shown in the inset of Fig. 2.

Shape of Discharge Coefficient Characteristic:—The formula given below was used for the calculation of the discharge coefficient. It was found that for the mass flows likely to be used in engine work, the effect of change of Reynolds number was very small, the predominating effect being the ratio of the pressure before the orifice to that after the orifice. Accordingly, in Fig. 2, the discharge coefficient is plotted against pressure ratio.

Pressure Recovery:—The pressure recovery of the air after passing through the orifice can be taken to be the same as for a circular orifice; that is m times the pressure drop across the orifice, where m is the ratio of the annulus area to the area before the disk of the orifice.

Capacity:—A unit installed in a pipe of diameter 10 in. measures the airflows under N.T.P. conditions up

"Do you mean you can take that big thing apart and can't even fix a little wheel on my typewriter?"

* Reported by the author, communicated by the Director of Scientific Research, Ministry of Aircraft Production and included in R.A.E. Reports and Memoranda No. 1934, November 1939.

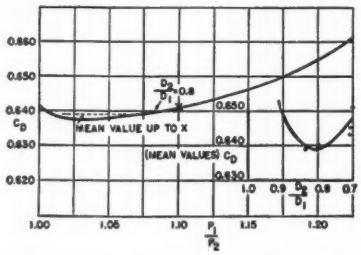


Fig. 2. Curves of relations of various factors in annular air-flow orifice. C_d=discharge coefficient. P_1=pressure before orifice. P_2=pressure after orifice. D_1=pipe internal diameter. D_2=disk diameter

to about 200 lb per min with an 8-in. disk and 300 lb per min with a 7-in. disk.

Conclusions:—For an orifice designed in accordance with the information given above, the discharge coefficient up to pressure ratios of about 1.10 can be taken as 0.645, independent of entry conditions. For more accurate work, the variation in the discharge coefficient due to the annulus width, shown in the inset of Fig. 2, should be taken into account.

The formula used in calculating the discharge coefficient was—

$$W = (K\, C_d A_2 P_1) \div \sqrt{T_1}$$

in which W = mass flow. K is a value dependent on several factors, principally R and $P_1 \div P_2$; the formula for calculating K is given in the original report. The other factors are: C_d = discharge coefficient; A_1 = area ahead of disk of orifice; A_2 = annulus area of orifice; $n = A_1 \div A_2 = 1 \div m$, where $m = A_2 \div A_1$; P_1 = pressure ahead of the orifice; P_2 = pressure after the orifice; T_1 = absolute temperature ahead of orifice; g = acceleration due to gravity, 32.2; γ = ratio of specific heats; R = difference of specific heats.

An approximate formula, which can be used in most cases in practice, and which is fairly accurate for a small pressure drop across the orifice, is:

$$W = A_2 C_d \sqrt{\frac{2g\, P_1\, (P_1 - P_2)}{RT_1\, (1 - [C_d^2 \div n^2])}}$$

Comments on Coal Quality and Coal Buying

By **JULIAN E. TOBEY,**
Director, Fairmont Coal Bureau

SOME consumers of coal today ask questions: When will steam coals get back to prewar quality? Are most of the coal operators putting in cleaning plants? These are perfectly fair questions and deserve fair and frank answers.

The author answered them with the comments given below, in a recent paper presented before the Technical Association of the Pulp and Paper Industry (TAPPI).

Engineers and consumers generally understand why quality went down during the fuel emergency (which, by the way, still exists) because of the opening up of marginal mines, and to a lesser degree the overtaxing of production facilities in some of the regular mines. In the main, wars are fought on marginal coals. In other words, these coals represent the difference between normal and wartime economy. They serve a most vital purpose during fuel emergencies in taking care of 25 to 30 per cent of the demand, but naturally have a very disturbing effect on the coal distribution pattern and consumers' plant operation.

These marginal coals will gradually slip out of the picture as new mining equipment replaces worn-out facilities in the regular-established mines, enabling the latter to increase mining capacity. At present, the serious car shortage and heavy export demand are complicating the situation. Some of the highest quality coal reserves were depleted during the war and increased production from reserves of lower quality will be necessary. To meet rising production costs, there will be a great increase in the tonnage of coals mechanically mined.

The number of cleaning plants will increase in fields where lower quality reserves are mined and where mechanized mining under bad roof and floor conditions materially increases the amount of impurities in the coal delivered to the tipple. Cleaning plants are a necessary adjunct to mechanized mining, where bad roof or floor conditions exist, or if the coal seam itself is high in impurities.

A Mechanical Field

Mechanized long before the war, one coal field, well known to the author, is an interesting exception. Here is a 7 or 8 ft. seam of solid clean coal, with only two partings of bone coal near the middle, each about ¾ in. thick, and this is combustible material. The roof is draw slate, and stable if protected from air and moisture. The floor is rock, with a hard, bony crust, which gives excellent separation from the coal. The cut is made at the top of the seam, rather than the bottom, leaving a few inches of hard coal to protect the draw slate roof.

When the coal is shot down it breaks clean from the floor and is picked up by loading machines and discharged into mine cars. As a result, steam slack sizes from the deep mines throughout this field will normally have an ash content between 8 to 10 per cent with the average not above 9 per cent. The run-of-mine average will be one or two per cent lower. In the case of this field, under present conditions, mechanical cleaning of steam coals is unnecessary and uneconomic.

Good Fuel-Burning Equipment Has Advantage

Coal cleaning and drying is an expensive manufacturing process, especially for the small steam sizes, involving both capital and operating charges amounting to 25 to 45 cents per ton. This cost must be passed on to the consumer just as are manufacturing costs in the paper and other industries. Consumers with modern fuel-burning equipment of conservative design are in an excellent position to save this cost and should continue to burn raw coal (unwashed) until a point is reached that, through sound accounting methods, it can be proved that mechanically-cleaned coal with its additional cost will reduce the cost of steam generation.

To answer more specifically the question, when will steam coals get back to prewar quality? As postwar conditions become more stabilized, coal quality will improve materially over average wartime quality. However, because of conditions mentioned earlier, the author does not expect the quality of raw coal to average quite as high as prewar. On the other hand, an increasing tonnage of high-quality coal will be available from cleaning plants.

Regarding the question of when to clean or not to clean coal, it may be helpful to point out the following. It is generally uneconomical both to the producer and consumer to remove from steam coals a small percentage of ash, say 2 per cent ash from 10 to 8 per cent, whereas, it may be highly worth-while to remove 8 per cent from a 16 per cent ash coal. This statement is of course over-simplified for the problem is complex, involving freight rates, moisture content and other variables.

The author believes that, from now on, 8 to 10 per cent ash will represent high quality steam coals in many areas, including the eastern seaboard.

Some Comments on Coal Buying

Some comments on buying coal for the new conservatively designed plants may be in order.

In general, the old plants, because of restricted design, are severely limited in coal selection and, as a result of this, buyers have little choice or opportunity to buy fuel on the

heat-energy basis. Coal prices are basically related to production costs and not to heating values *per se*. In addition, like any other commodity, coal prices are influenced by supply and demand.

Coals that possess all the physical and chemical properties for all-purpose uses, such as metallurgical, chemical, gas, domestic and steam coals, are naturally in highest demand. Other coals deficient in one or more properties are restricted as to certain uses, but are excellent for steam-raising purposes. The majority of the coal reserves of the country fall into the last category, and from these come the most economical steam coals.

The pulp and paper industry is undergoing rapid expansion and in no industry is fuel a more important item. The industry is going to burn progressively more coal and the matter of steady year-round supply under both normal and abnormal conditions is becoming increasingly important. Never before has it been so important for buyers to study carefully the long-range fuel requirements of the mills and to figure out which coal fields can best and most economically meet these long-range requirements.

Large mills should, by one of several means, attach themselves to large coal reserves through substantial producers. Here the author is not necessarily referring to long-term contracts, although he believes there will be an increasing amount of this type of business; but rather to plans in which the buyer would work more closely with fewer sources and with some mutual assurances in regard to continuity.

It is not good to jump from pillar to post in buying and selling coal. It does not promote good will, and costs both the consumer and producer money in the long run. It is not good for mills that burn substantial tonnages year in and year out to figuratively worry about where their next "fuel meal" is coming from; and by the same token, it is not good for the producers with large reserves to constantly worry about customer turnover. There is a more sensible approach.

Before presenting the foregoing comments on coal, the author had previously presented the results of a special study made by his organization of the new boiler units purchased by the pulp and paper industry in the Northeastern industrial area since the war. The title of the complete paper was A Fuel Engineering Study of Some Recent Boiler

PRACTICAL ENGINEER SECTION

DAMPER FOR FLOAT VALVE ELIMINATES VIBRATION

By C. L. SHOBE

A FLOAT VALVE is installed in the 4000 gal water tank over our plant to maintain the water level in the tank. Just at the point of shutting off, the float would start bouncing and set up a vibration in the 200 ft line that shook just about everything in the boiler room.

We overcame the vibration by brazing a damper, made of 1/16 in.

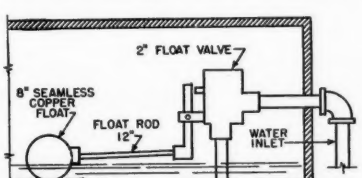


Fig. 1. Details of 13½ in. brass disc which was brazed to the bottom of the float to act as a damper for vibration

brass sheet, as in Fig. 1. The damper was placed parallel with the water line as much as possible, leaving 2 or 3 in. of water over the damper. This produced too much resistance, and the tendency of the float to vibrate was eliminated.

We were never able to determine the exact cause of the vibration, but finally attributed it to the waves or surges which were produced as the tank filled with water. These waves on the water surface caused the float to rise and fall, thereby making the valve open and close. This would shut off and turn on the water at regular intervals and cause surges in the supply line. We tried heavier float rods and rods of different lengths, but they did not help the situation.

Immortalize Yourself in Print

YOU, TOO, can make footprints on the sands of time. You can be an author—a man of distinction even, if you heed these words. Maybe you won't range alongside Shakespeare, Dickens or Sinclair Lewis but in years to come students of power engineering may know you as the guy that described that super demountable soot blower which you rigged up to impress the boss. Maybe it was only a trick arrangement to keep salesmen out of the boiler room but if you write it up, others will read it and bring you fame. If nothing more, at least you will experience the thrill of seeing your name in print.

All you need to do is to write about some item of interest around your plant or about some idea you may have about operation that will be of interest to others. Whatever your job, whether you are the boss or only the oiler's understudy, you undoubtedly run across things that other engineers would be interested in. So write them up and send them in to us for use in the Practical Engineer Section. If you have hints and kinks, descriptions of unusual repair jobs, interesting electrical or mechanical arrangements in the plant, suggestions for improving operation and efficiency, answers to questions—get them down on paper somehow and let us see them. Don't worry if you can't write perfect English or if you have no typewriter; write it out longhand, in your own words; we'll decipher your writing and rework it into readable English. Of course, if you can type it, so much the better, but typewritten copy is not strictly necessary. Put in sketches or diagrams wherever you can and these not need be finished drawings. Rough pencil sketches will do and our draftsman will make them into good-looking drawings—that's what our draftsman is for.

Remember, the important thing about the Practical Engineer Section is that it is primarily the place where you and all other power engineers have a chance to voice your opinions, and your "beefs," to discuss your problems—say what you like within the limits of good engineering manners. All we do is arrange and polish up what you send in.

And, don't forget, we will pay you for anything we publish. Maybe you won't get rich writing, but you will immortalize your name in print, and the extra cash won't hurt you—not with butter at 94 cents a pound.

Installations in the Pulp and Paper Industry. This study showed that in the design of the modern boiler units surveyed, prime consideration was given to the furnace and disposition of total heating surfaces, to the extent that the furnace has ample volume and sufficient water cooling to insure that furnace exit-gas temperatures would not exceed the fusion temperature of the ash on the oxidizing basis. Further, it was shown that pulverizers of ample capacity were used in all jobs and that stoker burning rates reflected good practice. Details of individual installation and design data on 65 paper and pulp mill installations were tabulated, showing that the units were all designed for use of a wide range of coal and belonged to the new era in power plant design.

THE CURSES AND BLESSINGS OF A HOT PROCESS HEATER AND SOFTENER

By W. F. LORGE

THE CONVERSION of a would-be Hot Process Heater and Softener, hand controlled, to a modern unit that is float controlled. Float switch opens solenoid valve on raw water and lime and soda ash proportioner and starts meter pump in basement and also starts water diffusing motor on top of softener and also illuminates pilot light in Engine Room visible to operator. Float switch reverses this action when softener is satisfied, as to water level, and shuts off pilot light. Solenoid valve closes and diffusing motor shuts down.

All improvements and materials were mostly made up from scrap found about the place and assembled in our maintenance shop. Even the solenoid operated valve was one found on the shelf, from an old machine, and put to work.

Close observation of the two sketches, will furnish evidence of lime contamination output of the old unit and the clear output of our present improved unit.

SETTING POLES BY DYNAMITE

ORDINARILY a "sand barrel" is used to set poles in sandy soil that requires shoring to prevent caving of the soil. If, however, you desire a quicker method, and if you have

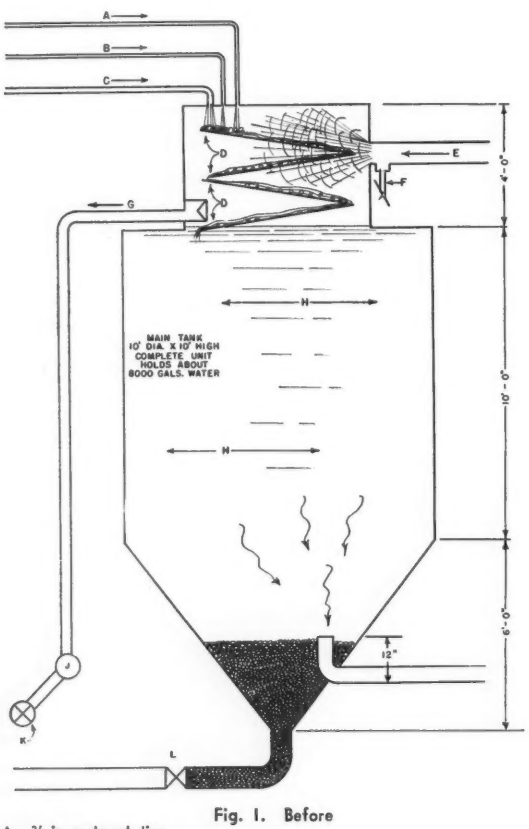


Fig. 1. Before

A. ⅜ in. soda ash line
B. ⅜ in. lime line
C. 2 in. cold raw water inlet (hand control)
A, B, C. All three lines to meter pump and lime and soda ash proportioner in basement (hand control)
D. Water trays
E. 8 in. seam inlet—3 to 5 lbs pressure
F. Drip line to trap below sewer
G. 4 in. overflow
H. Lime and soda ash treated water. No down-take manifold. Lime contaminated water to boilers
J. 4 in. trap
K. Sewer
L. Blow-off valve

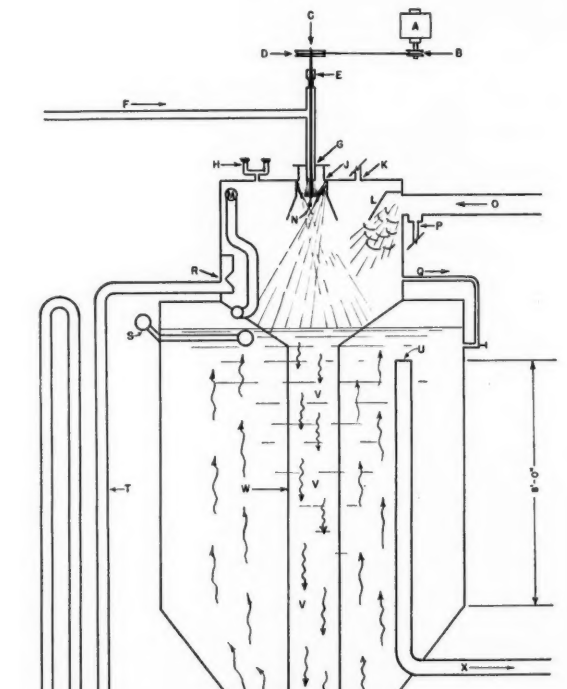
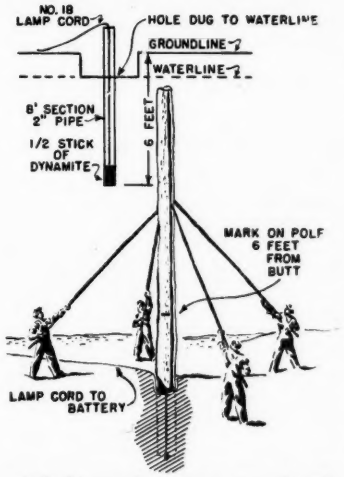


Fig. 2. After

A. Thurst bearing motor mounted vertical on bracket. 1/6 hp-1150 rpm 110 v
B. 2 in. motor "V" pulley
C. ¾ in. shaft—speed about 250 rpm
D. 10 in. "V" pulley and nut
E. Stuffing box and thrust bearing
F. Raw water inlet—lime and soda also injected in this line through proportioner and meter pump in basement
G. 3 in. pipe welded on ½ in. plate and bolted with gasket to 6 in. plate
H. Twin vacuum breakers
J. 6 in. pipe flange welded on here
K. To aeration
L. Baffle over steam inlet directing steam downward
M. Lower chamber equalizing 4 in. line to upper part of heater
N. Diffusing blade and nut—5 in. dia.
O. 8 in. steam inlet—3 to 5 lbs exhaust
P. To drip trap in basement and to sewer
Q. Water gage glass
R. "V" notch overflow and 4 in. pipe. Baffle over overflow so water cannot escape to sewer while being diffused and heated
S. Float, float rod and switch. Control operates diffusing motor and solenoid valve on meter pump in basement, both starting and stopping at same time. All wiring in conduit from this point
T. 4 in. pipe
U. Clear treated water
V. Treated water
W. Down-take manifold
X. Boiler feedwater to filters and pumps and then into boilers. Water at 205 to 210 F
Y. To sewer
Z. Blow-off valve



qualified powder men to do the work, we suggest the following procedure:

Dig the hole to a depth where water begins to seep in the hole, or until the soil begins to cave. Drive a length of 2-inch pipe into the hole, at its center, to the desired depth for the pole butt. Insert one-half to one full stick of dynamite (according to soil condition and depth) with cap in place, using the lead wires to lower the charge to the bottom of the pipe. Place a stick of wood inside the pipe to hold the charge in place, while the pipe is being withdrawn from the hole. Take the leads out of the pipe and connect them to the battery and plunger ready for the firing of the charge. Set the pole inside the shallow hole over the dynamite charge and have the men hold the pole in place with pikes, as illustrated in Fig. 1.

When the charge is fired, the pole will drop to the depth at which the charge was placed. It may be necessary to shoot a second charge once in a while, but usually the pole drops to the right depth the first time. If the work is handled by qualified powder men, there is no danger involved, as the dynamite charge is placed too deep to result in anything more than a dull thud and throwing water a foot or so out of the hole. *Line Material Company of Milwaukee, Wis.*

Questions and Answers

Question No. 422

QUESTIONS ON COAL HANDLING SYSTEMS

(1) AUTOMATIC SEQUENTIAL starting of coal handling equipment has many apparent advantages that have previously been discussed in the literature; and we know that a number of utility plants and industrial plants have installed and operated such equipment. But our operators are wondering whether or not it is becoming generally accepted practice, and would like to learn of the practicability of such automatic sequential control systems from engineers who have had experience with them.

(2) In installing outdoor belt conveyors for coal, what is the common practice concerning covering them for protection against the weather? Are there any data on the relative life of covered versus exposed coal conveyor belts?

(3) Do users of large outdoor belt coal conveyors operate them at low speed when not in service during cold weather, or is any effort made to keep belts warm in very cold weather?

Any comments that readers of POWER GENERATION may have on these subjects will prove most helpful to our engineers.

Pennsylvania T.H.

Editor's Note:—Details of coal-handling control system at Philo Station of American Gas & Electric Co. were given in POWER PLANT ENGINEERING, August and September, 1947. Comments from readers who have had experience with sequential controls will be most welcome and will bring out many valuable suggestions.

Question No. 423

HOW CALCULATE CONDENSER SPRING SUPPORTS?

I DO NOT recall ever having seen any data on analyzing the method of calculating spring supports on some of the larger condenser installations, where the condenser is hung directly from the turbine exhaust flange.

Can readers tell me how these supports are designed and whether the plant operators have to do anything about them during operation?

Philadelphia, Penna. F.L.H.

PRACTICAL ENGINEER SECTION

Question No. 424

WHY DESIGN BF PUMPS FOR SAFETY VALVE BLOW?

SOME POWER PLANT designers, in calculating boiler feed pump capacities, provide pumps for a head pressure high enough to pump full capacity into a boiler while all safety valves blow. Just what are the reasons for providing such large capacity?

Chicago, Ill. E.R.C.

Question No. 425

HE WANTS DATA ON CONDENSER TUBE AND SHELL EXPANSION

THERE IS AN INCREASING tendency to install large surface condensers with the tubes expanded at both ends, thus eliminating tube packing; and naturally, this gives rise to the problem of the expansion characteristics of two different metals and the method of compensating for them.

Surface condenser shell expansion joints are used to compensate for the above-mentioned conditions. But I have always wondered about the uniformity of movement of the floating tube sheet element, due to the difference of the inlet and outlet water temperatures. The difference naturally would cause a difference of tube expansion in the upper and lower tube banks, particularly in the two-pass type of condenser.

It seems to me this problem is of much importance to power plant operators and I would appreciate any information Q & A readers have to offer on it.

Where long tubes are used, this temperature difference, together with a considerable temperature rise in the circulating water, would tend to produce an appreciable difference in elongation of each pass—in other words, a greater movement in the upper tube bank due to the temperature rise of the circulating water. In all probability, this may be one of the contributing factors causing tube failure in this particular class of installation. The foregoing assumptions are naturally based on the general standard construction features; viz, a welded-steel shell with non-ferrous tubes, such as Admiralty metal, Muntz metal, copper, and so on.

In comparing the advertising photos of various manufacturers' equipment, it appears that there is no set rule for the design limitations applying to the maximum outside diameter of the shell expansion member in relation to the condenser shell diameter and the tube length. This comment is not to be construed

as a criticism of manufacturers' designs, for it is quite obvious that from the generous size of some expansion members supplied by a few builders, the problem is taken into consideration by them.

Philadelphia, Penna. F.L.H.

Question No. 426

SHOULD HE REMODEL THIS POWER PLANT OR BUILD A NEW ONE?

I AM CHIEF ENGINEER in a small Western college, where we are adding new buildings to the nine buildings already on our campus. These are now supplied with steam and electricity from the power plant described below. Two new buildings are now under construction and we feel very sure that we are to get two more new buildings within 12 or 18 months. We should like to have comments from Q & A readers on what would be the best thing for us to do in our power plant, not only to improve our service to the present buildings but to supply the added service required by the new buildings.

At present we have two 200-hp, and one 150-hp water-tube boilers operating at 125 psi. The boilers are fired with coal by pneumatic spreader stokers. These boilers are old, the 200-hp units having been installed in 1905.

We have three 150-kw, 220-v, d-c steam-engine-driven generators. We pump water from a deep well, which supplies 200 gpm, with a 220-v, d-c, motor-driven turbine pump.

Our electric demand in 1947 reached a high point of 800 amp per hr. The average demand is 193 kw. We are aware that our lighting is inadequate, and that we are denying the faculty of the college many electrical conveniences that are very helpful in their work, and that we expect to supply the faculty with, in case we do install proper steam and electric generating equipment for carrying the proposed increase in load.

At present, some buildings are heated by engine exhaust steam, others by live steam.

What in your opinion would be the most efficient method and the most economical present-day equipment to supply steam heat and electricity to the previously mentioned buildings, considering the fact that all the buildings are within a radius of 2000 ft from the central power plants?

What in your opinion would be the proper voltage to generate, and would you recommend a-c or d-c? We estimate our peak demand for electrical energy, with the addition of the proposed new buildings, to be 740 kw. The table shows steam demand for heating of the present and new buildings.

We will appreciate very much having this discussed by Q & A readers since we are anxious to have the latest and most efficient steam generating and electric generating equipment in our plant.

V.A.C.

Editor's Note:—Here is obviously a problem for a competent consulting engineer, who will earn his fee from the saving he can make in working out this problem. We have advised V. A. C. to this effect, calling his attention also to the fact that a consulting engineer will need much more information about the steam demand fluctuations than are given in the table.

In many respects, this problem is similar, on a smaller scale, to the problem originally faced by the University of Illinois in 1940, as reviewed in the article U of I Growth Requires Abbott Power Station Expansion by Gordon V. Carlson, POWER GENERATION, February 1948.

Table showing estimated steam demand for heating and miscellaneous services in small college, as given by V. A. C.

Existing Buildings	*Vol. Cu Ft*	*Steam Demand*	*Present Heating Service*
Men's Dorm.	240,000	2,500 #/Hr.	Exhaust
Library	358,153	3,600 "	Live
Science Hall	201,758	2,000 "	Exhaust
Agricultural Bldg.	201,758	2,000 "	Exhaust
Manual Arts	98,766	500 "	Exhaust
Academic Hall	1,130,335	11,000 "	Exhaust
Leming	197,065	2,000 "	Live
Albert Hall	170,689	1,700 "	Live
Training School	293,040	3,000 "	Exhaust
SUB TOTALS	2,891,564	28,300 #/Hr.	
Diversified Demand		18,800 #/Hr.	
New Buildings			
Men's Dorm.	482,000	4,200 #/Hr.	
Service Bldg.	363,000	3,600 #/Hr.	
SUB TOTALS	3,736,564	36,100 #/Hr.	
Diversified Demand		24,000 #/Hr.	
Proposed Buildings			
Health & Education Bldg.	500,000	5,000 #/Hr.	
Science Hall	200,000	2,000 "	
GRAND TOTALS	4,436,564	43,100 #/Hr.	
Diversified Demand		28,700 #/Hr.	

Answer No. 401

WHY A LIFT FITTING?

WHENEVER HE IS installing or relocating a unit heater, said E.H.H. in the December issue, and finds the return line anywhere from a few inches to 3 ft above the heater outlet, he is required by a company rule to install a lift fitting between the trap and the return line. He and his maintenance staff want to know what, where and why anything is gained by the use of such a lift fitting.

The primary object of a lift fitting, as we understand it, is to form a water seal between the trap and return line so that the trap will not lose its prime and also to provide a method for forming a more solid column of condensate in the rising leg so that the condensate will flow more uniformly to the return line, by allowing it to cool so that it will not give off vapor, which locks in the rising leg. In short, the purpose of the lift fitting is to make condensate flow into the return line by gravity.

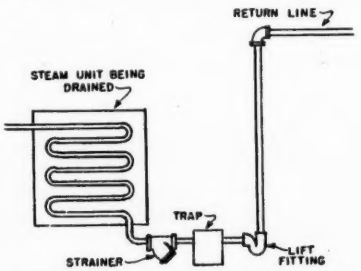


Fig. 1. Diagram of a unit heater hook-up as E.H.H. is required to connect it

The reasoning is that if you have a hook-up as shown in Fig. 1, the trap is discharging condensate at about 212 F. If there is a vacuum on the return line, as we assume there is, when the trap shuts off after having discharged hot condensate, some of this condensate will flash into vapor, which has to be removed by the return line before condensate can flow through it. This release of vapor, air and other gases tends to break the vacuum and may

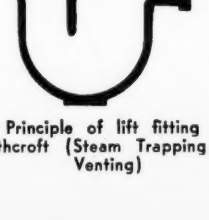


Fig. 2. Principle of lift fitting as shown by Northcroft (Steam Trapping and Air Venting)

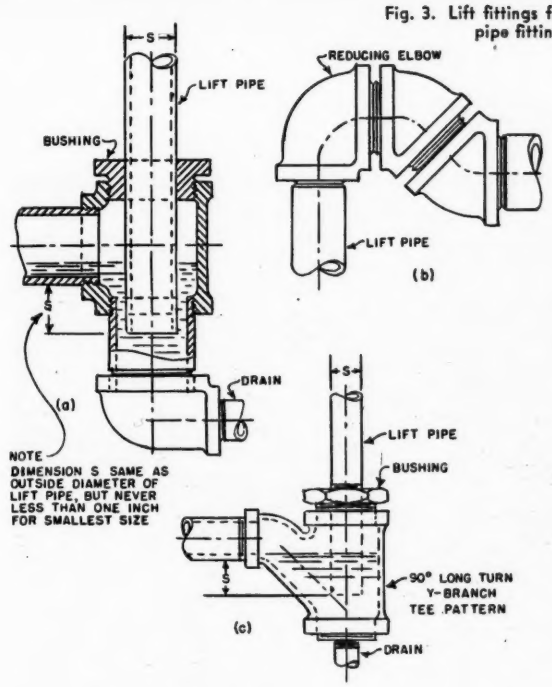


Fig. 3. Lift fittings fabricated from screwed pipe fittings (Fischer)

cause trouble with the vacuum pump.

The lift fitting may be constructed as shown in Fig. 2 or, if made up from standard fittings, may look like Fig. 3. The outlet area is smaller than the inlet area. The vertical lift pipe is made one or two sizes smaller than the horizontal return and has its lower end submerged in the well of the lower lift fitting, below the level of the lower horizontal pipe. A similar fitting, used in the inverted position, is often placed at the upper end of the lift pipe, to prevent the water from draining back again after it has reached the top. The installation would be as shown in Fig. 4.

The condensate accumulating in the well of the lower lift fitting seals the lower end of the vertical pipe and thus reduces the vacuum slightly on the inlet side of the fitting. When this occurs, the pressure builds up in the inlet line and forces the water up through the lift pipe in piston-like slugs. The ascending water, carrying air, vapor and other gases with it, is prevented from falling back when it reaches the top and then flows by gravity into the horizontal return line. It is often recommended that the upper lift fitting be connected into the top of the return line.

Lifts of over 5 or 6 ft should not be made in one step but in two or more shorter steps, depending on the height to which the condensate is to be raised. Thus, if a return line is long and sloping up, and the condensate to be handled very hot, the return line should be arranged with lift fittings to lift the condensate in steps. Details of how this should be done are given in an article, How Trouble with a Vacuum Pump was Corrected with Lift Fittings by W. F. Fischer, in a recent issue of *Heating, Piping and Air Conditioning.*

Northcroft, in Steam Trapping and Air Venting (Chemical Publishing Co.), recommends the use of a check valve following the trap, where condensate is to be lifted, as shown in Fig. 6.

Cost of fabricating lift fittings from standard fittings may be more than that of commercial manufactured lift fittings, says Fischer.

Northcroft in Steam Trapping and Air Venting recommends the lift fitting primarily to deliver condensate from the bottom of a coil in a tank, where the trap cannot be located right at the coil outlet, as in Fig. 5. For conditions outlined by E.E.H., however, Northcroft recommends the connections shown in Fig. 6.

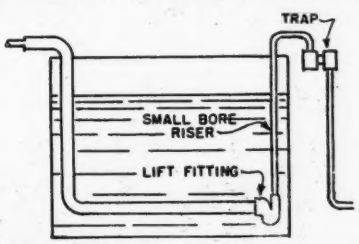


Fig. 5. Use of lift fitting when trap cannot be installed at outlet of heater unit. (Northcroft)

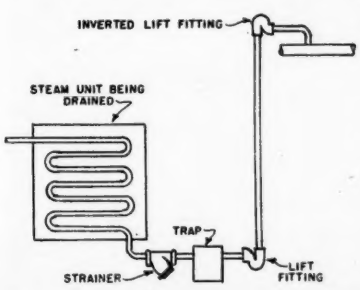


Fig 4. Method advocated by Fischer for connecting lift fittings

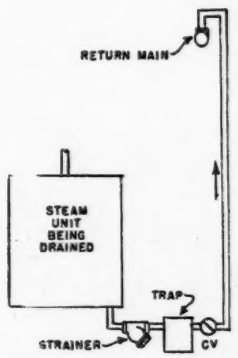


Fig. 6. Connections recommended by Northcroft for lifting condensate

Answer No. 413

WHAT METHODS KEEP POWER PLANTS CLEAN?

Attention to Every Detail, says Quintero

THE WRITER has seen many power plants in this country and has seen references to the cleanliness of some power plants in the United States. He can truthfully say that he works in a clean power plant.

In our plant every one has a share in the housekeeping program. Every turbine, motor, pump, fan, valve, is under the care of a qualified man who is responsible for the cleanliness of the equipment. Also we have a sweeper on each shift.

We have, in different parts of the building, waste cans painted with brilliant colors. On the walls and in strategic places we have notices calling the attention of the workers to cleanliness, so that they will not leave papers, rags, cotton waste, and the like on the floors. We also have compressed air outlets in many parts of the plant for blowing dirt.

For the cleanliness of the boilers and ducts in the boiler room, we have hoses connected to the inlet side of the induced-draft fans, at the other with vacuum cleaner nozzles on the hoses. Finally, we keep in mind that every clean plant is a well-run plant.

Bauta, Cuba — EUSEBIO QUINTERO

MATHEMATICAL SIGNS AND COMMONLY USED ABBREVIATIONS

$+$	Plus (sign of addition)
$+$	Positive
$-$	Minus (sign of subtraction)
$-$	Negative
$\pm$ ($\mp$)	Plus or minus (minus or plus)
$\times$	Multiplied by (multiplication sign)
$\cdot$	Multiplied by (multiplication sign)
$\div$	Divided by (division sign)
$:$	Divided by (division sign)
$:$	Is to (in proportion)
$=$	Equals
$\neq$	Is not equal to
$\equiv$	Is identical to
$::$	Equals (in proportion)
$\simeq$ $\approx$ $\cong$	Approximately equals
$>$	Greater than
$<$	Less than
$\geq$	Greater than or equal to
$\leq$	Less than or equal to
$\rightarrow$	Approaches as a limit
$\propto$	Varies directly as
$\therefore$	Therefore
$\sqrt{\ }$	Square root
$\sqrt[3]{\ }$	Cube root
$\sqrt[4]{\ }$	4th root
$\sqrt[n]{\ }$	nth root
a^2	a squared (2d power of a)
a^3	a cubed (3d power of a)
a^4	4th power of a
a^n	nth power of a
a^{-n}	$1 \div a^n$
$\frac{1}{n}$	Reciprocal value of n
log	Logarithm
hyp. log, nat. log, $\log_e$, ln	Hyperbolic, natural or Napierian logarithm
e	Base of hyp. logarithms (2.71828)
lim.	Limit value (of an expression)
∞	Infinity
α	Alpha (commonly used to denote angles)
β	Beta (commonly used to denote angles)
γ	Gamma (commonly used to denote angles)
θ	Theta (commonly used to denote angles)
ϕ	Phi
μ	Mu (coefficient of friction)

π	Pi (3.1416)
Σ	Sigma (sign of summation)
ω	Omega (angles measured in radians)
g	Acceleration due to gravity (32.16 ft. per sec. per sec.)
i (or j)	Imaginary quantity ($\sqrt{-1}$)
sin	Sine
cos	Cosine
tan (tg) (tang)	Tangent
cot (ctg)	Cotangent
sec	Secant
cosec	Cosecant
versin	Versed sine
covers	Coversed sine
$\sin^{-1} a$ arcsin a	Arc the sine of which is a
$(\sin a)^{-1}$	Reciprocal of sin a ($1 \div \sin a$)
$\sinh x$	Hyperbolic sine of x
$\cosh x$	Hyperbolic cosine of x
Δ	Delta (increment of)
δ	Delta (variation of)
d	Differential (in calculus)
$\int$	Integral (in calculus)
$\int_b^a$	Integral between the limits a and b
!	$5! = 1 \times 2 \times 3 \times 4 \times 5$
$\angle$	Angle
$\llcorner$	Right angle
$\perp$	Perpendicular to
$\triangle$	Triangle
$\odot$	Circle
$\square$	Parallelogram
$^\circ$	Degree (circular arc or temperature)
$'$	Minutes or feet
$''$	Seconds or inches
a'	a prime
a''	a double prime
a_1	a sub one
a_2	a sub two
a_n	a sub n
( )	Parentheses
[ ]	Brackets
{ }	Braces

Reproduced from Heating and Ventilating's Engineering Databook.

Take a *good* look at a *Liability*

Any boiler plant becomes a liability when improper water conditioning eats up profits by causing excessive blowdown, carryover . . . scale. But this liability can be turned into an asset with *correct* water conditioning . . . a matter of careful and scientific control.

W. H. & L. D. BETZ is an organization of engineers and chemists specializing in the solution of all industrial water problems. Years of experience have made Betz water conditioning service scientifically correct . . . complete . . . economical. Our staff of engineers will welcome the opportunity of discussing your boiler water problems . . .
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BOILER WATER CONDITIONING • COOLING WATER CONDITIONING • INDUSTRIAL WASTE TREATMENT

Standard Builds 1250-Psi Topping Plant for Whiting Refinery-III

By **D. A. MONRO**
Chief Engineer
Standard Oil Co. (Indiana)

and

A. T. MILBROOK
Assistant Chief Engineer
Whiting Refinery

IN THE April 1948 issue, Part I of this article discussed the basis for the general design and the features of principal equipment and arrangement in the new Stanolind Station No. 3, a 1250-psi topping plant built by Standard Oil Co. (Indiana) at its Whiting refinery.

This plant, just going into service, contains three 300,000-lb-per-hr boilers supplying steam at 1250 psi, 900 F to two 10,000-kw turbine generators, which exhaust at 400 psi to supply steam to the existing 400-psi steam system.

One of the principal features of the new topping plant is its design for 100 per cent feedwater make-up. since no condensate returns from the refinery are used. Dual-circulation boilers of new design, as described in Part II, May issue, are installed, designed to produce minimum blowdown and to minimize silica concentration, not only for the benefit of the 1250-psi topping turbines but also because much of the 400-psi steam they supply to the refinery passes through 400-psi and 100-psi refinery turbines.

Source of make-up water for the plant is Lake Michigan water, first used as cooling water in refinery processes. As noted in Part I, previous experience with treatment of such water in other refineries, satisfactory experience in treating it in a 2-stage hot-process water treatment system, built to serve the war-expanded 400-psi power plant at Whiting, and careful engineering studies by National Aluminate Co. and Professor F. G. Straub, led to the design of this water treatment system to reduce silica content of boiler feedwater to much less than 1 ppm. Details of equipment are given in the list. Figure 2 is a portion of Fig. 2, Part I, repeated to show flow of water and steam in the feedwater treatment system.

Water Conditioning Equipment Stanolind Station No. 3

Continued from page 68, April issue

Designers and Constructors
Stone & Webster Engineering Corp.

Feedwater Treating Plant; 2-stage Hot Process Type.....Allis-Chalmers Mfg. Co., in collaboration with American Water Softener Co.

Hot Process Water Softeners
3 Lime-Soda Sedimentation Tanks — Welded and X-rayed steel plate. Capacity each—80,000 gph Lake Michigan water at 90F minimum, normal temperature 160 to 180F; Normal Operating Pressure—10 psig; Design Pressure—20 psig plus hydrostatic head; Retention Time—1½ hrs at full rated delivery; Sludge Capacity—2000 lb solids. Tank Diameter —30'-0",—Height overall: 59'-4",—Height straight shell: 28'-9",—Slope Bottom Cone —55 degrees with hor.

Tank Accessories—Film Spray Heater — Elliott Co. No. 8 Double Deck; Multi-speed Agitator (4 speeds); Vacuum Breakers (6 - 16"); Internal Uptake Funnel; Overflow Valve; Raw Water Regulating Valve and Level Control Vent Condenser—173 sq ft—Elliott Co. Automatic Sludge Blowoff Control; Manual Sludge Blowoff; Sludge Recirculation; Gage Glasses, High and Low Level Alarms, Temperature Recorder, Sampling Connections, etc.

2 Phosphate Sedimentation Tanks
Duplicates of Lime-Soda tanks in all respects except accessories, which do not include film spray heater, vent condenser, regulating valve and lever control, but do include the others.

Pressure Filters
16 Filters—welded steel plate;—11'-0" dia. x 5'-6" straight shell height. Des. Pres.—80 psig. Filter Material—Anthrafilt—total depth 45 in. Provision for future installation of Palmer agitator.

Chemical Feed Tanks
4 Lime-Soda Feeders—Welded steel plate; —11'-0" dia. x 6'-0" straight shell height. Motor driven propeller type vertical agitator. Selsyn controlled electro-magnetic proportioner. Dust Eductors.
2 Two Compartment Phosphate Feeders (1 compt. future)—Welded steel plate; 6'-0" x 6'-0" x 6'-0" high. Motor driven propeller type vertical agitator. Selsyn controlled electro-magnetic proportioner.
2 Two compartment Retardant Feeders (1 compt. future) Duplicates of phosphate feeders.
10 Sump Suction Tanks for Chemical Feed Pumps—Welded Steel plate;—each 12" x 36" x 18" deep. Float operated inlet valve.

Chemical Feed Pumps
Allis-Chalmers Mfg. Co.
4 Lime-soda Solution Pumps—10 gpm, 125 ft head, 3 hp; 3 Phosphate Solution Pumps—10 gpm, 125 ft head, 3 hp; 3 Retardant Solution Pumps—10 gpm, 161 ft head, 5 hp.; All pumps 1½ x 1¼ Type SS-DH Electrifugal.

Sludge Recirculation & Blowoff
5 Schutte & Koerting Water Jet Eductors: 5 Fischer & Porter Rotameter with Rota-Alarm; 7 Clear Water Pumps—Allis Chalmers Electrifugal—1½ x 1¼ Type SS-DH—60 gpm, 130 ft head, 5 hp. 1 Sludge Blowoff Tank—Graver Corp. 1 Sludge Vapor Condenser—Foster Wheeler Corp.

Pressure Type Filters
Graver Tank & Mfg. Co.
(for Cooling Water Service)
3 Filters—Welded steel plate;—9'-0" dia. x 5'-0" straight shell height. Des. Press. —125 psig. Filter Material—Sand and gravel—total depth 36 in.

HEATERS AND EXCHANGERS

Deaerating Heaters.....Cochrane Corp.
3 Deaerator, tray type, horizontal drum —9'-0" dia. x 18'-0" long.
Storage tank — horizontal drum — 10'-0" dia. x 29'-3" long.
Both drums of welded copper bearing steel plate construction designed for 30 psi W.P. Deaerating and heating capacity at outlet.

Inlet water at 40F	760,000 lb/hr
Inlet water at 240 F	850,000 lb/hr
Steam pressure—	10 psi
Storage capacity — deaerated water and condensate	2,000 cu ft
Cc. of oxygen per liter of water leaving heater—	0.005

2 Vent condensers per heater—500 sq ft H.S. each.
Condensate from each vent condenser—

Inlet water at 40F—	50,000 lb/hr
Inlet water at 240 F—	15,950 lb/hr

Inlet Regulating Valve—8" pilot operated Fisher
Overflow Valve—12" pilot operated Fisher.
Flow Recorder Controllers—Treated water and retardant chemical feed control, Raw water and lime-soda
Bailey Meter Co.
Flow Meter and Controller, Phosphate tank influent and phosphate feed control .....Sparling
Flow Recorder and Indicator—Backwash to Filters .....Brown Instrument Co.
Flow indicators—Effluent from each filter, Backwash to Cooling Water filters
Level Recorders—Sedimentation Tanks ..... Foxboro Co.
Level Recorders—Treated and Raw Water Storage Tanks.—Deaerating Heater Feed Water, Storage Compartment with pneumatic transmission to Meriam level indicator—Fuel Gas Holder—Pressure Recorders—(steam, water, gas and Oil)
Brown Instrument Co.
Indicators — Condensate Storage Level Tank — Deaerating Heater Condensate Storage Compartment
Yarnall-Waring Co.

TANKS AND DRUMS

Storage Tanks
General American Transportation Co.
2—35' dia. x 50' high treated water storage—720,000 gal.
1—16' dia. x 20' high Condensate Storage —30,000 gal.
2—25' dia. x 40' high Fuel Oil Storage —294,000 gal.
Equipped with finger type heating coils.

Flash Tanks—for Continuous Blowdown System . . . J. G. Heggie Mfg. Company
2—3' dia. x 6' vertical—600 psi des. press. —100 psi initial—400 psi future. Hagan ‡10-N steam purifier on outlet.
2—3' dia. x 6' vertical—150 psi des. press. —100 psi W.P. Hagan ‡10-N steam purifier on outlet.
2—5'6" dia. x 7' vertical—25 psi des. press. —10 psi W.P. Hagan ‡10-N steam purifier on outlet.

Blowoff Tank.....J. G. Heggie Mfg. Co.
2—5' dia. x 5'4" vertical—25 psi des. press.

Air Receivers.....J. G. Heggie Mfg. Co.
2—3'6" dia. x 10' vertical—375 psi W.P. —96 cu ft. 1—3'6" dia. x 10' vertical—125 psi W.P.—96 cu ft capacity.

OTHER EQUIPMENT FOR POWER PLANT

Wood Piling.....N. S. Mackie Co.
Structural Steel.....American Bridge Co.
Brick, Interior.....Goshen Brick & Clay Co.
Bonner & Marshall Brick Co.
Brick, Interior—Goshen Brick & Clay Co.
Shade 901 Face Brick
Howard-Matz Brick Co.
Temporary Siding—Corrugated transite with Cemesto board backing
Illinois Roofing & Insulation Company
Precast Concrete Roof
Federal Cement Tile Co.
Roofing, Flashing and Roof Insulation
Tri-City Roofing & Sheet Metal Works
Steel Sash.....Wm. Bayley Co.
Industrial Type Steel Doors
Detroit Steel Products Co.
Hollow Metal Doors and Frames
Jamestown Metal Corp.
Rolling Steel Doors.....R. C. Mahon Co.
Floor Finish.....Kalman Floor Co.
Grating and Stair Treads
Standard Steel Spring Co.
Roof Ventilators—Continuous
Swartwout Company
Ventilating Fans—Exhaust Type
Davidson Fan Co.
Ventilating Fans—Axial Flow Type
Wolverine Equipment Co.
Ventilating Fans—Centrifugal
American Blower Corp.
Ventilating Units.....Trane Company
Unit Heaters.....American Blower Corp.
Convectors.....Shaw-Perkins Mfg. Co.
Turbine Room Crane—30 Tons
Harnischfeger Corp.
Fan Room Hoist—10 Ton.....Whiting Corp.
Freight and Passenger Elevator—4000 lb.
Otis Elevator Co.
Laboratory Furniture.....Brown-Morse Co.
Vacuum Cleaning System
Allen-Sherman-Hoff Co.

Why this *isn't* just another Spreader Stoker

Three reasons why you should consider "F & E" Spreader Stokers before purchasing that new stoker equipment.

1) "F & E" ELECTRO-HYDRAULIC DRIVE—self-contained; minimum of working parts, all encased operating in a bath of oil. Completely safeguarded against breakdowns due to tramp iron or other foreign materials being fed in with the coal; no gears, ratchets, sheer pins, etc. Any number of coal feeds from minimum to maximum.

2) "F & E" ALTERNATE PUSHER COAL FEEDERS—the pushers of each coal feeder are made in four sections; of the step pusher design, these pusher sections cover the entire hopper bottom. They operate in alternate directions, that is while two sections are advancing forward, two sections are receding backward and vice versa—thus providing a continuous discharge of coal upon the distributors and assuring non-clogging, dependable and continuous coal feed.

3) "F & E" INCREMENTAL CONTROL VALVE—regulates operation of the hydraulic drive; lends itself perfectly to automatic control; instantly transfering to the coal feeding mechanism, the regulating action of the automatic controls and this with the complete elimination of shafts, racks and complicated mechanism.

It takes experience to design and build such a stoker, and the "F & E" Spreader Stoker reflects years of identification with the stoker business. If you want top performance in your next stoker installation, specify the "F & E" Spreader Stoker. Write today for Illustrated Bulletin No. 1301.

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The feedwater treating system adjoins the power station and is laid out to permit an ultimate expansion equivalent to that of the steam generating capacity. The initial installation consists of three lime-soda sedimentation tanks, one of which will serve as a spare, and two phosphate sedimentation tanks. Each pair of tanks comprising a unit has a net capacity of 80,000 gph and each tank has a retention time of 1½ hr.

Chemicals for water treatment will be stored in bags and barrels in a building, Fig. 1, having a storage area of 4,700 sq ft. The storage room is adjacent to a railroad siding, with its floor at the level of a railroad car. The chemical mixing and proportioning room is located next to the storage room. The mixing tanks are slightly above grade elevation and arranged to permit dumping of the chemical charges from a platform connecting with, and at the same level as, the storage room floor. Separate tanks are provided for mixing lime and soda, phosphate, and retardant solutions and each tank is equipped with its own agitator, proportioning mechanism, pump suction tank, and chemical pump. Controls for all chemical proportioning and feeding mechanisms and pumps are mounted on a central control board, on which are also mounted all flow and level recorders, pressure gages and other instruments required for control of the entire feedwater treating system.

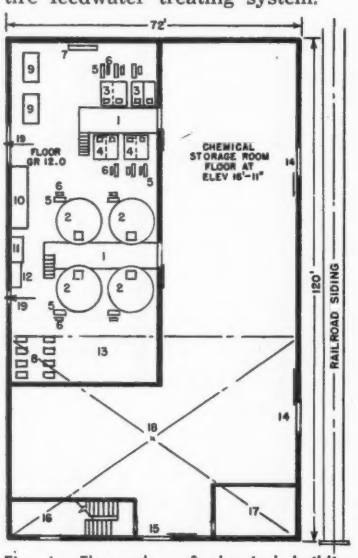
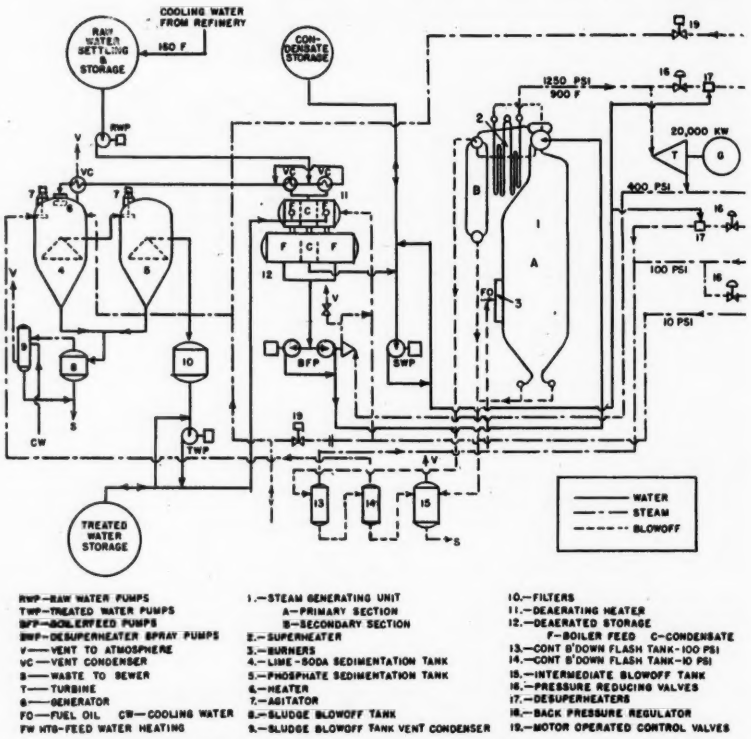


Fig. 1. Floor plan of chemical building, Stanolind Station No. 3

1—Tank charging platform; 2—Lime-soda mixing tanks; 3—Phosphate solution tanks, 2 compartment; 4—Retardant solution tanks, 2 compartment; 5—Pump suction tanks; 6—Chemical pumps; 7—Solution water cooler; 8—Clear water pumps for sludge recirculation; 9—Filter backwash pumps; 10—Gage board; 11—Sampling bench; 12—Sample bottle rack; 13—Space for motor starters; 14—Unloading doors—railroad cars; 15—Unloading doors—trucks; 16—Stair well; 17—Fan room; 18—2nd floor area occupied by: Water testing laboratory, water testing laboratory, fuels testing laboratory, wash & locker room for power station; overhead bridges connect chemical bldg with Stations No. 1 & 3; 19—To water treating tanks & filters



RWP—RAW WATER PUMPS
TWP—TREATED WATER PUMPS
BFP—BOILERFEED PUMPS
SWP—DESUPERHEATER SPRAY PUMPS
V—VENT TO ATMOSPHERE
VC—VENT CONDENSER
S—WASTE TO SEWER
T—TURBINE
G—GENERATOR
FO—FUEL OIL CW—COOLING WATER
FW HTG—FEED WATER HEATING

1.—STEAM GENERATING UNIT
A—PRIMARY SECTION
B—SECONDARY SECTION
2.—SUPERHEATER
3.—BURNERS
4.—LIME-SODA SEDIMENTATION TANK
5.—PHOSPHATE SEDIMENTATION TANK
6.—HEATER
7.—AGITATOR
8.—SLUDGE BLOWOFF TANK
9.—SLUDGE BLOWOFF TANK VENT CONDENSER

10.—FILTERS
11.—DEAERATING HEATER
12.—DEAERATED STORAGE
F—BOILER FEED C—CONDENSATE
13.—CONT B'DOWN FLASH TANK—100 PSI
14.—CONT B'DOWN FLASH TANK—10 PSI
15.—INTERMEDIATE BLOWOFF TANK
16.—PRESSURE REDUCING VALVES
17.—DESUPERHEATERS
18.—BACK PRESSURE REGULATOR
19.—MOTOR OPERATED CONTROL VALVES

Fig. 2. Portion of simplified flow diagram of new 1250-psi topping plant for Whiting refinery, repeated from Fig. 2, Part I, April issue, page 67, to show connections of feedwater treatment system

Each sedimentation tank is equipped with means for recirculating sludge from the sludge cone to the top of the tank, to accelerate the precipitation. This consists of an ejector, a flow meter and a clear water pump. The ejector and flow meter are located adjacent to the tank to reduce the length of the sludge pipes. The clear water pumps for all tanks are located in the mixing room.

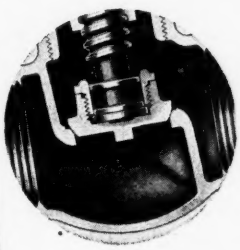
All raw water is discharged for presettling and storage into two 50 ft by 50 ft tanks adjacent to the water treating plant at Station No. 1. Temperature of the incoming raw water varies with the season of the year and with changes in process operations over a normal range of 120 F to 180 F. Water to Station No. 3 will flow through two 18-in. lines to the raw water pumps in the pump bay of the boiler room, thence through the vent condensers on the deaerating heaters to the spray heaters of the sedimentation tanks. In an emergency, the raw water pumps can take suction from the cooling-water supply system of the refinery, which may have a temperature of 40 F or less in winter. Under emergency conditions, with a water temperature entering the deaerator vent condensers of 40 F, the outlet temperature will be 162 F. At maximum capacity, with a temperature of 180 F entering the vent condensers, the outlet temperature will be 238 F.

In the sedimentation tanks, the temperature will be raised to 240 F corresponding to an exhaust steam pressure of 10 psi. Full capacity of the treating tanks can be maintained with a raw water inlet temperature as low as 90 F. Steam for heating in the treating tanks is supplied from the refinery exhaust steam mains and from the continuous blowdown flash drums. Because of the danger of contamination with oil from reciprocating steam drives, refinery exhaust steam is not permitted to enter the deaerators. The steam for deaeration comes from turbine drives within the station, or from the low pressure turbine-generator units in Station No. 1—See Fig. 2, Part I.

The effluent from the phosphate sedimentation tanks flows through conventional type pressure filters using anthracite coal as the filtering medium. Two motor-driven backwash pumps are located in the chemical building mixing room. All sedimentation tanks and filters are out of doors with stairs and platforms for access to all valves and other equipment requiring servicing. The structure supporting the pipes leading to and from the boiler room has been made to serve also as a bridge to the platforms at the top of the sedimentation tanks, thus permitting the operators to use the

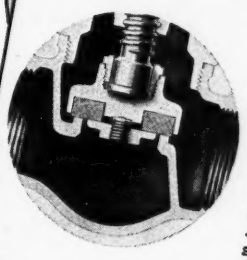
(Continued on page 108)

Guide for Selecting KENNEDY BRONZE GLOBE VALVES



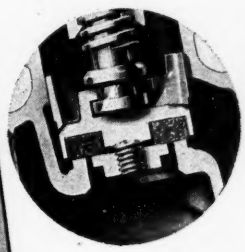
BRONZE DISC
Screwed Bonnet

This valve is designed for standard pressure, general service. Like all Kennedy Bronze Globe and Angle Valves this type can be repacked under pressure when wide open.



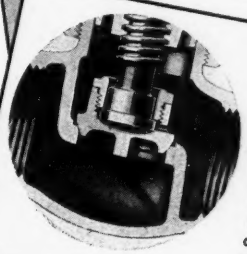
RENEWABLE COMPOSITION DISC
Screwed Bonnet

The discs in these standard-pressure valves are built to standard dimensions . . . those carried in stock by all supply houses. Kennedy offers various compositions . . . each selected to meet specific operating conditions. The exceptionally high raised seat assures longer disc life.



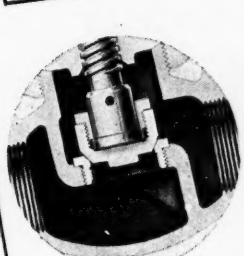
RENEWABLE COMPOSITION DISC
Union Bonnet

The convenient Slip-on Disc Holder speeds up renewing the disc on these 150 lb. Kennedy valves. This holder is accurately guided in the body by four guided prongs which maintain alignment and prevent binding.



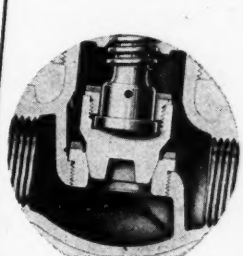
REGRINDING DISC
Union Bonnet

The discs of these 125 lb. and 200 lb. valves are designed to permit repeated regrinding . . . without removing the valve from the line. The body, bonnet, union bonnet ring and disc are made of the same metal as used for 300 lb. Kennedy valves.



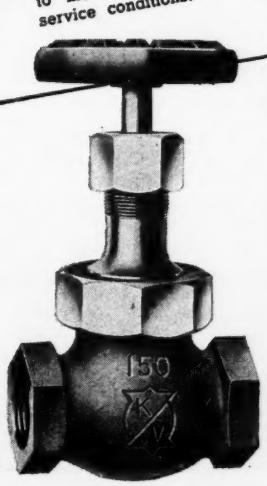
FULL-WAY DISC
Union Bonnet
Renewable Seat Ring

These 200 lb. and 300 lb. valves have renewable discs and seat rings of tough, wear resisting nickel-copper alloy. They can be furnished in special alloys to meet unusually severe service conditions.



PLUG-TYPE DISC
Union Bonnet
Renewable Seat Ring

The extra wide seating surfaces of these 200 lb. and 300 lb. Kennedy valves make them highly resistant to wire drawing. The plug-type disc design assures precise throttling control. Nickel-copper alloy for discs and seat rings are standard. Special alloys for unusual service conditions are available.



In addition to these bronze globe and angle valves, the extensive Kennedy line also includes bronze gate and check valves, iron body gate, globe, angle and check valves, malleable iron and bronze screwed fittings, and cast iron flanged fittings and flanges.

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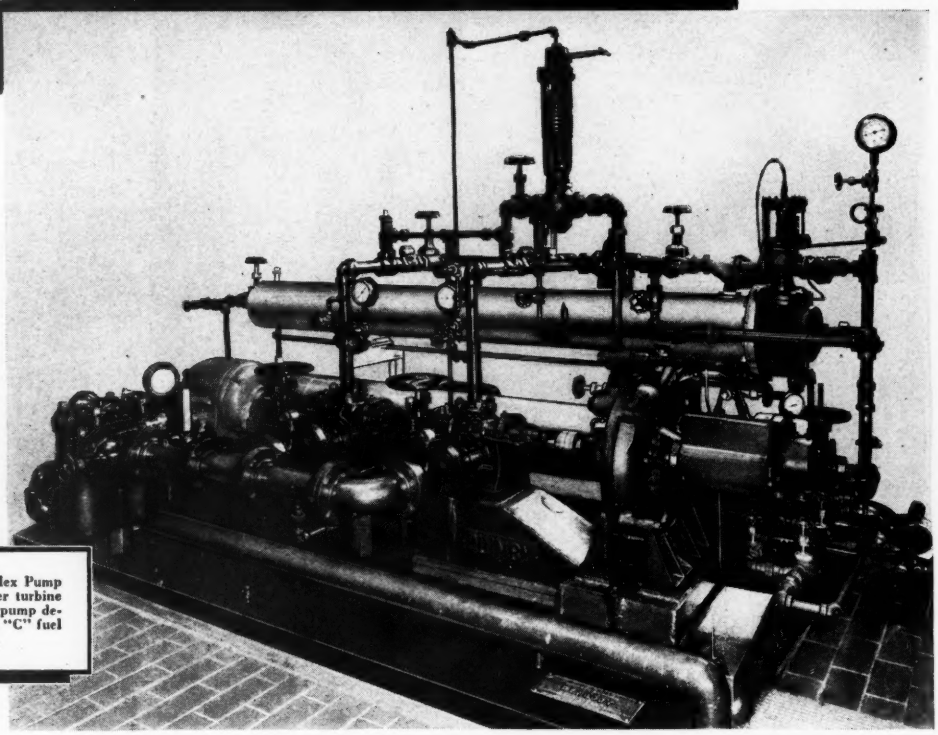

Typical Peabody Duplex Pump and Heater Set. Either turbine or motor driven screw pump delivers 12 GPM Bunker "C" fuel at 250 lbs. and 220°F.

. . . the completely automatic PEABODY FUEL OIL PUMP and HEATER SETS

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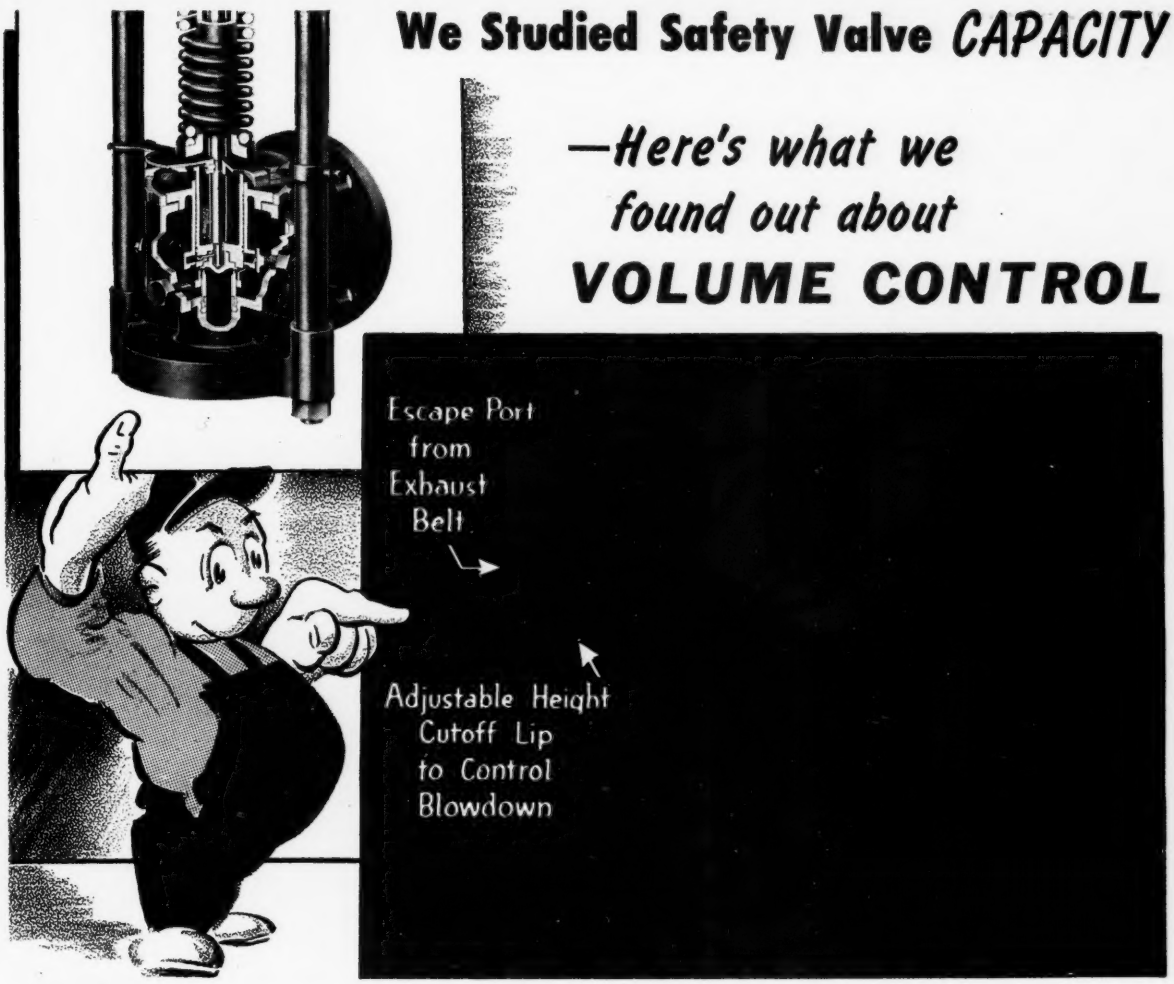
—*Here's what we found out about* VOLUME CONTROL



We found... that there's a lot more to "full capacity" than a full bored nozzle and high lift. Ability to *pass* steam and ability to *control* it are two entirely different things.

We found... that the first step toward control is to get rid of turbulence, and that by guiding the flow over properly designed, smooth machined surfaces, we could reduce turbulence to a negligible minimum.

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Dry Type Transformers Supply Auxiliaries at Southwark

Undesirability of using liquid-filled transformers to supply station service buses at Southwark Station of Philadelphia Electric Company led to the installation of three, 2000 kva self-cooled, single-phase cores and coils, which were assembled in a single case. With forced-air cooling this unit has a continuous rating of 10,000 kva. Saving in weight 20%

By G. R. MONROE
Transformer Engineer,
Westinghouse Electric Corp.

and

W. E. KNOUSE
Senior Engineer,
Philadelphia Electric Company

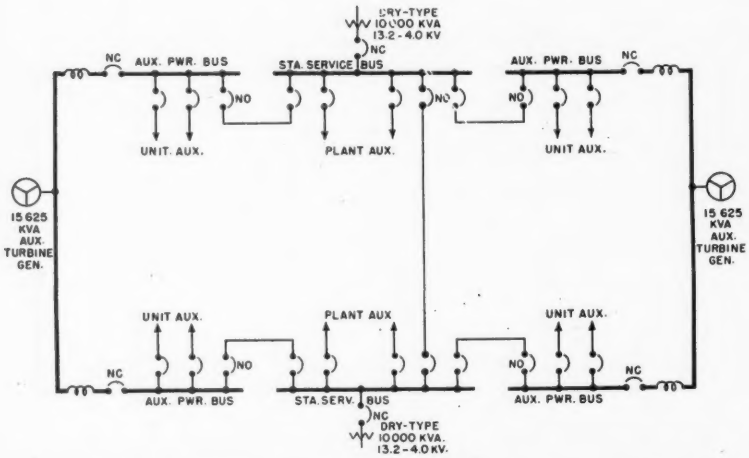


Fig. 1. The four auxiliary-power buses are normally supplied from two 12,500-kva turbine generators and operated independently from the two station-service busses supplied by the 10,000-kva dry-type transformers. Emergency power can be supplied to any of the auxiliary-power buses from the dry-type transformers by closing the normally open air breakers

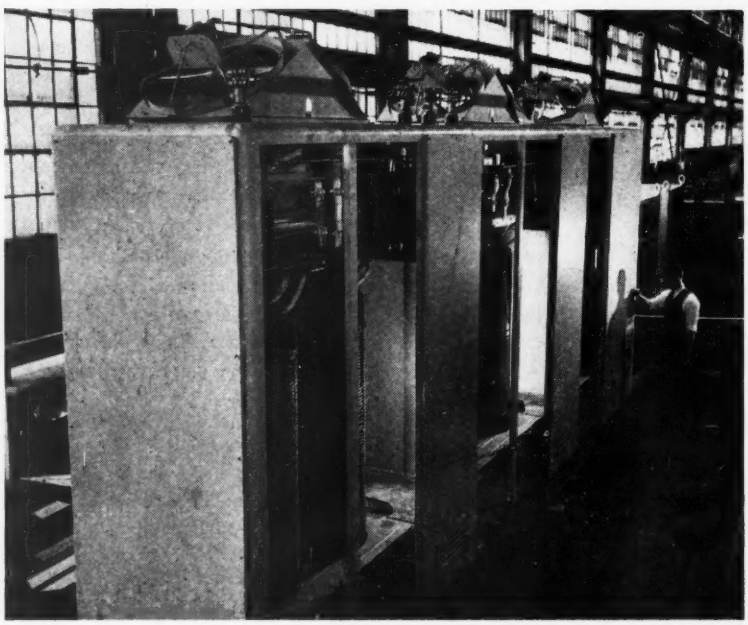


Fig. 2. Shown in the process of construction at the Westinghouse plant in Sharon, Pennsylvania, this dry-type transformer consists of three cores and coils mounted in a sheet metal case

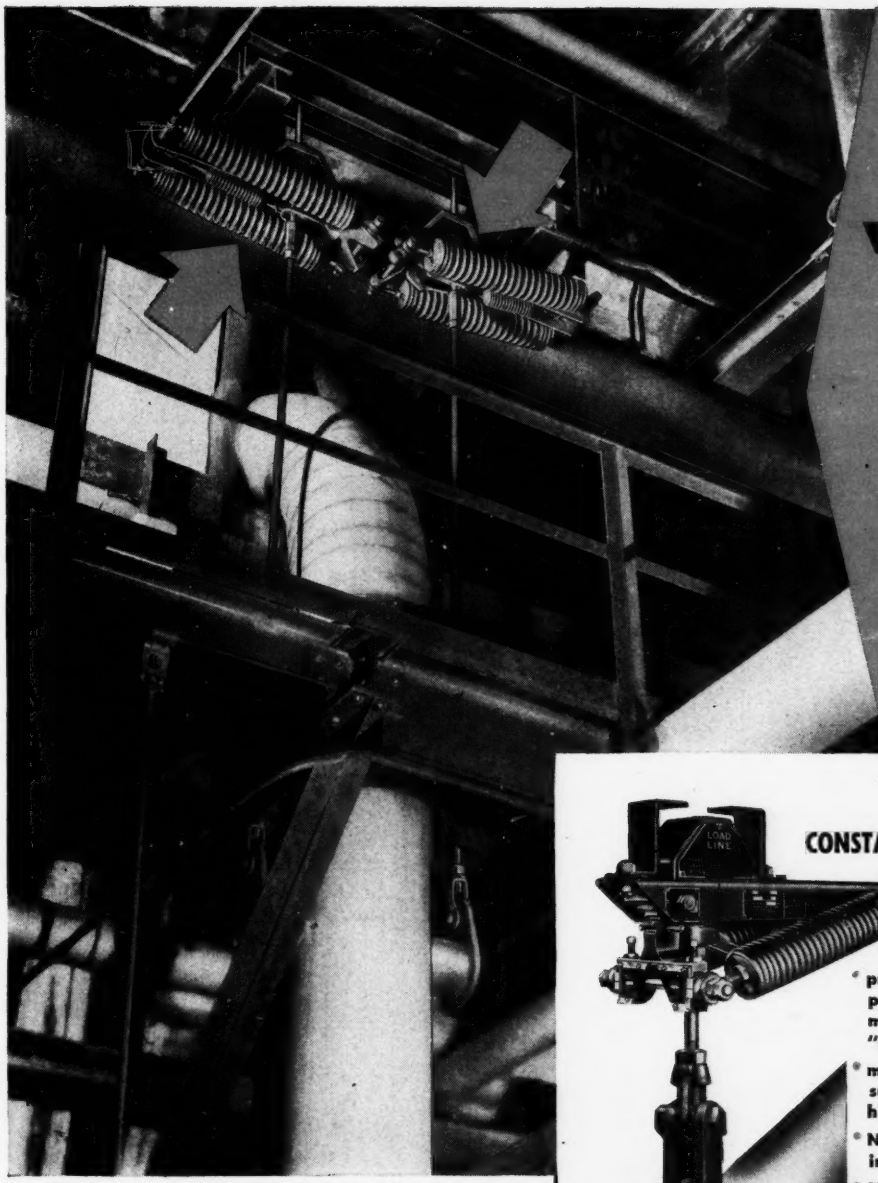
TWO, 10,000-kva, dry-type transformers of an unusual design are used to to supply the station-service buses and to provide back-up power for station auxiliaries at the new Southwark Station of the Philadelphia Electric Company. Since the station represents a substantial portion of the system capacity a high degree of reliability is required of the auxiliary power supply. Even a momentary loss of auxiliary power for the pulverized-coal-fired boilers would put out the fires for approximately one-half hour.

A 12,500 kw turbine generator normally supplies two auxiliary-power bus sections to which the auxiliaries for a single 150,000-kw main unit are connected. A second auxiliary-power turbine generator and two other buses provide auxiliary power for the second main unit. Two station-service buses, each supplied by one of the 10,000 kva dry-type transformers, can be readily connected to these auxiliary-power buses by switching in the event of failure or outage of the auxiliary turbine generators. Figure 1 shows the general arrangement of these buses, transformers, and auxiliary generators.

The transformers, each fed from separate 13.8-kv bus sections, are designed to provide a reliable alternate supply to the auxiliaries for the main units in addition to all other station power and lighting. This dual function requires that these transformers have a continuous rating of 10,000 kva.

Three-phase, dry-type transformers of such a large size were not commercially available, so three, 2000-kva, self-cooled, single-phase cores and coils were assembled in one sectionalized case, which with the application of forced-air cooling gave the required continuous rating of 10,000 kva. The units are rated at 13,800 v on the high side and 2400 v on the low side. A total of seven identical core-and-coil units were purchased, six of them to be used for the two banks and the seventh to act as a spare to replace any unit in either bank. The arrangement of the units in banks of three with a common frame and enclosure permitted most efficient use of the space available, most economical external connections and still gave all the advantages of single-phase units. In case of a failure of one unit, the single phase spare can be quickly installed, reducing outage time to a minimum. Components can be handled as single-phase units during installation. Class B insula-

(Continued on page 125)



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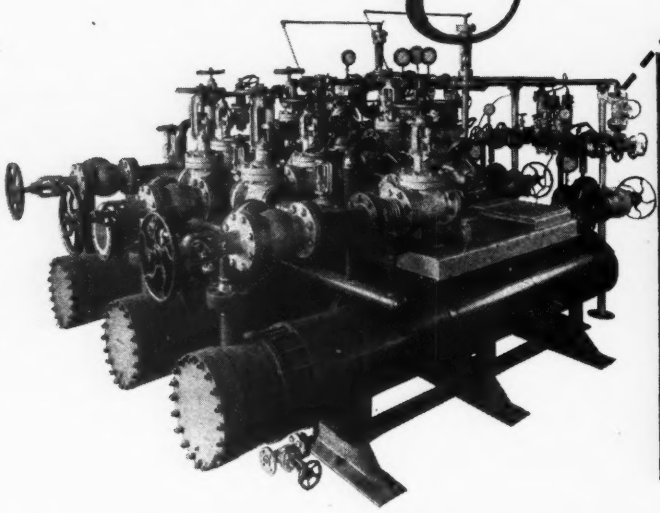

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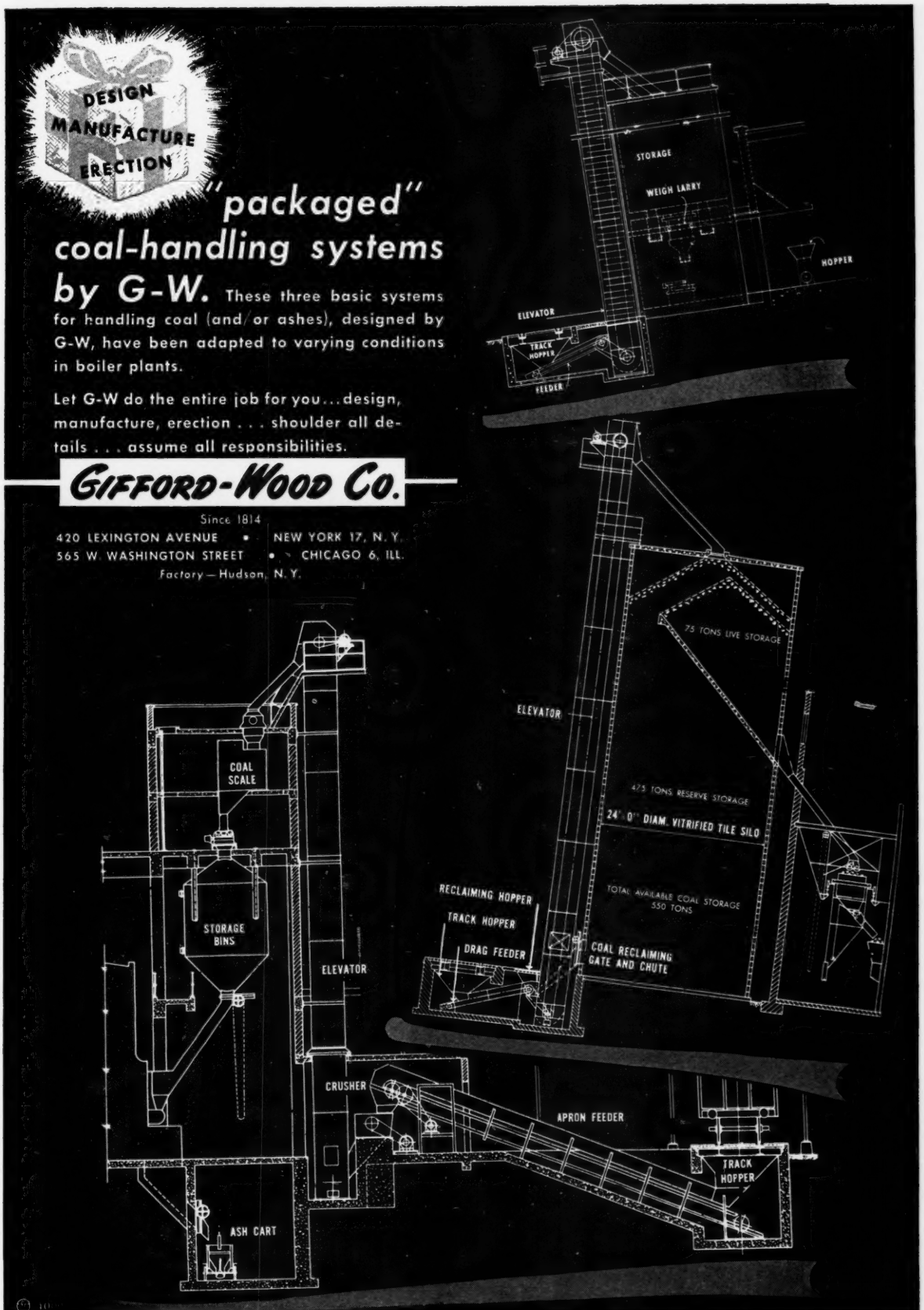

71-1-1

BEHIND THE IRON CURTAIN

what goes on—beyond this barrier?

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COMING EVENTS

ASME—The fall meeting of the American Society of Mechanical Engineers to be held at Reed College, Portland, Oregon, September 7-9.

Refractories—The Fall Meeting of the Refractories Division of the American Ceramic Society to be held at the Hotel Conneaut, Conneaut Lake Park, Pennsylvania, September 9-10.

Instrument Society—Instrument Society of America annual meeting to be held in Convention Hall, Philadelphia, September 12-17.

Instruments—American Society of Mechanical Engineers Instrument and Regulators Meeting to be held in Convention Hall, Philadelphia, September 13-17.

AISE—Iron and Steel Exposition and Convention to be held at the Cleveland Public Auditorium, Cleveland, September 28-October 1.

ACS—Fifth National Chemical Exposition of the American Chemical Society to be held at the Chicago Coliseum, Chicago, October 12-16.

ASCE—1948 Fall Meeting of the American Society of Civil Engineers to be held in the Statler Hotel, Boston, October 13-15.

Water Conference—The Ninth Annual Water Conference of the Engineers' Society of Western Pennsylvania will be held in the Hotel Wm. Penn, Pittsburgh, October 18-20.

ASM—Annual Convention of the American Society for Metals to be held at the Benjamin Franklin Hotel, Philadelphia, October 23-29.

AIMME—Annual Fall Meeting of the Institute of Metals Division American Institute of Mining and Metallurgical Engineers to be held at the Hotel Adelphia, Philadelphia, October 25-28.

AWS—Annual Convention of the American Welding Society to be held at the Bellevue-Stratford Hotel, Philadelphia, October 25-29.

Metal Exposition—National Metal Exposition to be held at the Commercial Museum and Convention Halls, Philadelphia, October 25-29.

SNDT—Annual Convention of the Society for Non-Destructive Testing to be held at the Hotel Adelphia, Philadelphia, October 27 and 28.

ASME—The annual meeting of the American Society of Mechanical Engineers to be held at the Hotel Pennsylvania and New Yorker, New York, November 28-December 3.

Power Show—18th National Exposition of Power and Mechanical Engineering will be held in the Grand Central Palace, New York, November 29 to December 4.

TRAINING CONFERENCE ON INDUSTRIAL EXPERIMENTATION

A FIVE-DAY training conference in Industrial Experimentation will be offered by the Engineering School of Columbia University, New York, September 14-18, 1948. The course is intended to provide both formal and practical insight into fundamentally effective techniques for persons with a background of experience and at least one course in statistics, quality control, or the equivalent.

Arrangements have been made for dining as a group at the Men's Faculty Club. Provision has also been made for inexpensive lodging on campus. The fee for the Conference, including all books and supplies and all lunches and dinners at the Men's Faculty Club is $100.00. Further inquiries and requests for brochure and application may be addressed to Professor S. B. Littauer, Department of Industrial Engineering, Columbia University, New York City 27.

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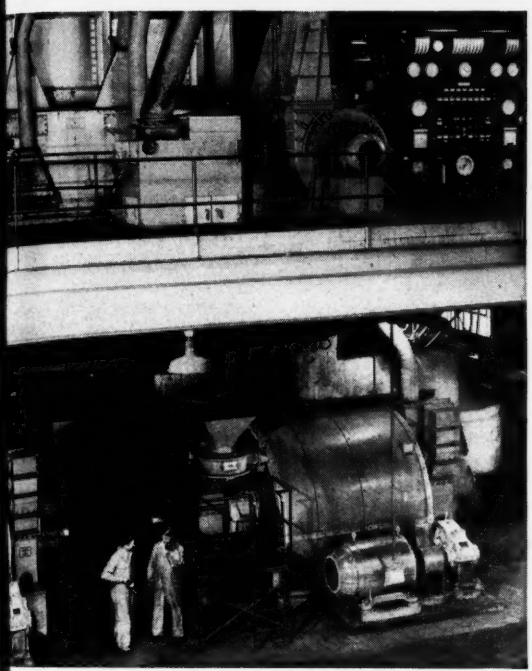

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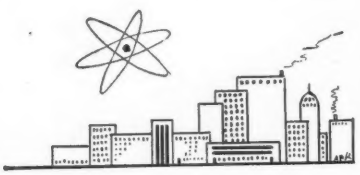
ATOMICS

(Continued from page 75)

bombs. Power production is not considered very urgent and is being approached in a cautious, step-by-step, take-no-chance, manner. Air Force and Navy strategists on the other hand are extremely anxious to have atomic engines they could use for propulsion. The Air Force has a two-year old project, NEPA—Nuclear Energy for Propulsion of Aircraft. This has just emerged from the paperwork stage to the point where the Air Force wants to try to build an experimental engine. The navy is now making preliminary plans for NEPS—Nuclear Energy for Propulsion of Ships-project.

Some military thinkers are inclined to believe that under present conditions, atomic power production should rate a higher priority than bomb development. Their argument is that even if we produced a bomb ten times more powerful than those already used its destructiveness would scarcely be doubled. Therefore, improved delivery of bombs which would get more of them



through to the target is more promising than improved bombs.

The Navy is especially interested in building atomic power plants since ocean going vessels are naturally large and heavy and the shielding problem is of minor importance. Since naval development is not dictated by commercial considerations it is quite possible that we shall see the first atomic power plants installed in naval vessels.

As a commercially disinterested observer I find it somewhat amusing though at the same time pathetic to see how each particular group strives to retain its ascendency—its place in the sun. I have already referred to the coal man's speech before the power salesmen. In his effort to minimize the importance of nuclear energy as a possible power source, he seized upon all sorts of quotations from what he thought were authorities to substantiate his opinions. Many of these references were, naturally, from other coal interests. He quoted Professor Oliphant of the British Ministry of Supply—his article, "Atomic Energy Will *Never* Oust Coal" published in the June 1947 issue of Coal Magazine, by the British National Coal Board. Said Professor Oliphant: "As to the future of Coal, it is clear that for a considerable time to come coal will remain our prime source of industrial power and heat, and it would be a mistake to rely at this stage on the solution of British power problems by any other means."

If, as so many of those with selfish interests to promote insist, the possibility of developing atomic power is so remote, why are so many of the commercial coal and oil companies and agencies concerned about it? Last summer (on July 25, 1947) the American Mining Congress set up a committee on atomic energy to keep abreast of this *momentous* development and to study its possible effects on bituminous coal and anthracite. The utility interests also have a committee on the development of atomic energy but in this case the interest is genuine. The utilities are not concerned whether they generate electric power by the use of coal or as a result of nuclear fission, the main thing they are concerned about is that the private companies will continue to run the power business.

It is, of course, needless to refer to all the various groups interested in atomic energy in detail but the very fact that they are so interested indicates that atomic energy may be more important as a competing influence than their spokesmen care to admit.

This question as to the future of atomic energy always brings to mind a statement which Dr. Robert Fox Bacher, the nuclear physicist of the U.S. Atomic Energy Commission made during a Congressional investigation last year. Said Dr. Bacher, "Whenever I hear statements made by people who say that it will be fifty years before atomic energy is achieved in any usable form, I am always inclined to turn around and look backward in time over what has happened in the last four years."

Tag!

A NEW phase in use of radioactive tracers for industrial research is indicated by the recent completion of the largest tracer experiment ever conducted, and probably the first using full-scale industrial process equipment. Sponsored by the Republic Steel Corp., the experiment was conducted in their Cleveland plant by Arthur D. Little, Inc. For over a decade, biologists and medical workers have used tracers. Although over 75 per cent are still used in biological work, use of these "tagged" atoms in industry has increased greatly in the year and a half since the Atomic Energy Commission has made many new kinds available at lower prices. Now that industrial workers are learning how and where to use the tracers, they expect to solve many knotty research and control problems.

The recent study was one step in a program for keeping undesirable sulfur out of steel, and is typical of the instances where tracers are especially useful. Sulfur enters steel in many ways—with the coke derived from coal, or with ore, limestone, scrap, or fuel oil. Some of it leaves the system in slag or flue gases, but some reaches the finished steel. In the finished steel, one cannot tell which raw material supplied the sulfur, except by tedious and inconclusive statistical correlation of sulfur content of the raw materials with that of the steel. This method showed coal to be the chief culprit, but steelmakers still were not certain which of the chemical forms of sulfur in the coal got through to the coke and then entered the blast furnace.

There are two important forms of sulfur in coal, pyritic and organic. Since the forms change in the coke oven, there is no chemical method for learning whether the surviving sulfur in the coke comes from the original pyritic or organic sulfur, or whether low-pyritic coal or low-organic coal is the better raw material. If one of the forms is tagged with radioactive atoms, however, its travels can be followed very precisely with radioactivity counters. In the present work, a small amount of artificial pyrites was made from radioactive sulfur and thoroughly mixed with twelve tons of coal, the normal charge to a coke oven. The proportion of the coke's sulfur which had come from the pyrites was then found by measuring the radioactivity of the sulfur. This proportion was about the same as in the original coal, indicating that both forms are carried over to the coke equally, and that there is no advantage in buying coal with a low pyritic-sulfur content. More tests are planned to trace sulfur in other materials and chemical combinations through the steelmaking process.

Radioactive tracers have also been used in such jobs as determining the concentration of toxic fumes in industrial plants, measuring the lubricant applied to textile fibers in amounts so small that ordinary measurements fail, determining the minute amount of metal transferred when a shaft rotates in a bearing, and studying the mechanism by which plants produce food from carbon dioxide, water, and other nutrients by photosynthesis.

Use of tracers to control industrial processes is being considered. As an example, radioactive phosphorus added to a Bessemer steel furnace would show when the last impurity, nearly always phosphorus, had been removed from the steel. Automatic

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controls could also be connected electrically to radioactivity-measuring instruments to turn down and shut off the Bessemer at the right time.

Research with tracers is characterized by directness and simplicity. Often, as in the coke-oven work, the experiment can be run in full-scale equipment. This is important, for there is sometimes serious doubt whether a conclusion reached in the laboratory will hold in the plant itself. Radioactive materials from the atomic pile are not expensive. The sulfur for this study cost only about $50, compared with thousands of dollars prewar, when radioactive materials were made in the cyclotron. Better measuring instruments are now available, and more technologists are familiar with radioactivity. Since research using AEC tracers is made public, this familiarity is expected to grow.

On the other hand, not all elements have radioactive forms suitable for tracer uses. For example, radioactive oxygen loses about half its radioactivity every two minutes. Many important radioactive elements are not available from the atomic pile, and must still be synthesized in a cyclotron at much greater cost. The AEC restricts purchase and use of radioactive elements to protect the experimenter and the general public against misuse. The Commission considers the applicant's professional qualifications, the instruments available for safeguarding health, and the intended use. The requirements of the AEC reflect the danger possible with radioactive materials. A properly planned experiment should involve precautions such as the use of a minimum amount of active material, appropriate shielding, avoidance of inhalation and ingestion of the material, and safe disposal of all waste containing active materials. In the coke experiment, special precautions were taken, such as devising techniques to allow use of only small amounts of radioactive materials.

The potentialities of the tracer method of research so far outweigh its restrictions that its future is considered brilliant. Research directors are reconsidering many research projects, even those previously abandoned as impractical, to see if this new tool can be used.

12 Million Volt Electrostatic Accelerator for Los Alamos

Largest pressurized Van de Graaf generator to be constructed at Los Alamos Scientific Laboratory for Nuclear Research. It will provide a flexibility and precision in control unattainable with existing types of accelerators

APPROVAL of construction at the University of California Los Alamos Scientific Laboratory of an electrostatic accelerator designed to yield positive ions with energies up to 12,000,000 electron volts was announced early in June by Carroll L. Tyler, manager of the Atomic Energy Commission's Office of Santa Fe Directed Operations. This accelerator will be, so far as is known, the largest and most powerful laboratory research tool of its type in the world. Together with the associated laboratory buildings it will cost approximately $2,000,000 and will take some two years to build.

The unique features of an electrostatic accelerator center around the flexibility of its energy control and in the extremely high precision with which this control can be maintained. The particle accelerators now under construction for energies in the multi-million or even billion electron volt range do not have these features, nor are they particularly adaptable to study the properties of both light and complex nuclei below 20,000,000 electron volts. There is need for much more precise data in this range. It is of prime importance to nuclear physics, to nuclear chemistry and to nuclear engineering.

In addition to the possibility of design for high precision in energy control, which in this case is to be one-tenth of one percent, the electrostatic accelerator has other advantages. The experimenter can change from one kind of ion to another, e.g., from protons to deuterons, with comparative ease. Further, the energies of these particles will be continuously variable from 2,000,000 v to 12,000,000 v. By making the proper choice of accelerated particles and of target material, mono-energetic neutron beams of any energy between 30,000 and 30,000,000 electron volts will be available.

The electrostatic generators is a pressurized version of the Van de Graaf generator which achieved its first marked development and success at the hands of Professor R. G. Herb, of the University of Wisconsin.

Plans for this pressurized Van de Graaf unit were started early in 1946 by a group under the direction of Dr. J. L. McKibben and the project was first approved in December of that year. Because no such accelerator has been built which operates above approximately 4,000,000 v, it was necessary to develop the design and to conduct many tests on designs and materials before proceeding with construction. Final approval of actual construction was granted by the Atomic Energy Commission in March, 1948.

The generator proper is enclosed in a steel pressure vessel 13.5 feet in diameter and 39 ft high which can be lifted by a 150 ton crane to expose the vital interior parts of servicing. This vessel will support internal pressures as great as 18 atmospheres.

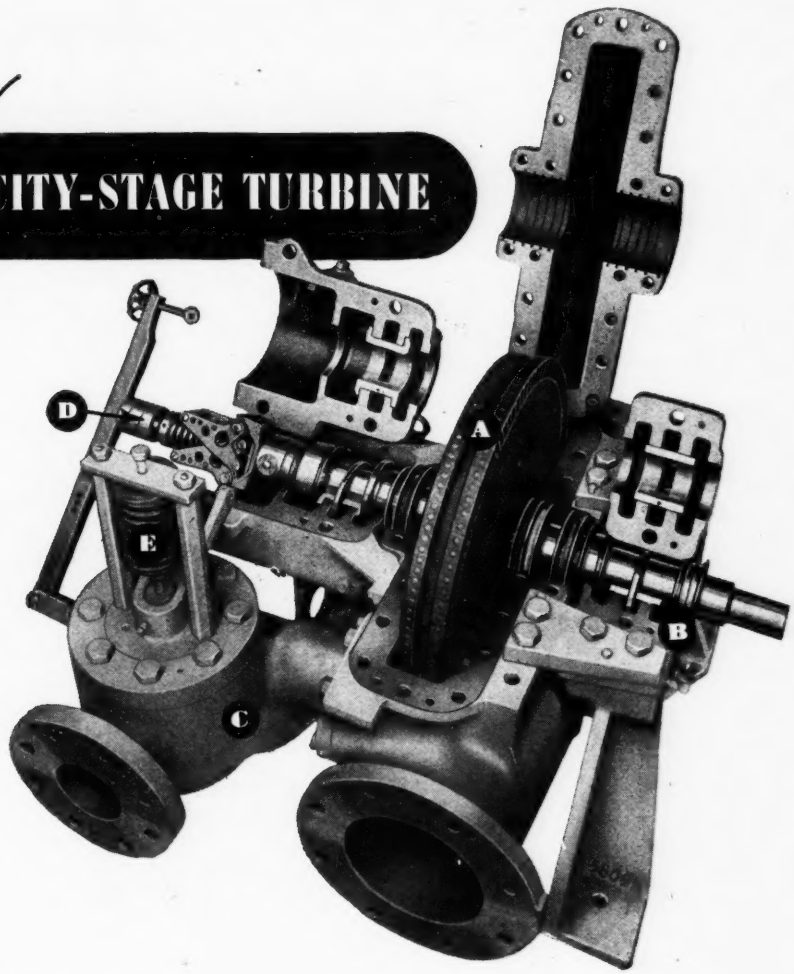
The heart of the accelerator is contained in a vertical column 25 ft high, the upper five feet being devoted to the production of the ions and the lower 20 ft to their acceleration. This lower section is formed of a stack of 150 steel plates 40 in in diameter and separated by insulators. In a rectangular slot within this column and from bottom to top runs a 30-in. wide cotton belt driven at a mile a minute speed by a 100-horsepower motor. Electric charge is sprayed on this belt at the base of the column and is carried to the top where it is removed from the belt. A very great potential difference may thus be built up between the upper electrode and the ground. This potential difference will then be used to accelerate charged particles down two evacuated tubes also contained in the column. By means of an electrostatic lens in the upper part of each evacuated tube the ions are focused into a sharp beam just as electrons are focused in an oscilloscope tube. One of these ion beams is used to monitor the energy. The other is bent to the horizontal by means of an electromagnet whence it enters the target room and may be directed towards any of several target assemblies.

The charge transported to the upper electrode would escape in the form of tremendous sparks to the pressure vessel at the relatively low potential of three quarters of a million volts if it were not for the high pressures of gases used and an arrangement of four potential smoothing steel inter-shells. It is expected that the design will suppress sparks up to an electrode potential of 12,000,000 v.

A new feature of this electrostatic generator is a pressure tight "separation" column which encloses the inner column with its belt and accelerating tubes and isolates it from the very high pressure region. This separation column may be locked to the outside pressure vessel so that the two may be lifted simultaneously. It will thus be unnecessary to release the compressed gas from the large volume of the pressure tank when it is required to service the vital parts of the generator contained in the inner column.

The New

DE LAVAL VELOCITY-STAGE TURBINE



A *Improved bucket and nozzle ring design,* for high efficiency.

B *Center line support and flexible mountings,* to avoid misalignment from thermal expansion.

C *Steam chest in lower half of casing,* to permit removal of casing cover without disturbing piping.

D *Improved speed control.* Balanced regulating valve and direct acting governor permit close speed regulation. Speed can be varied readily while turbine is running.

E *Separate trip mechanism* and emergency closing valve, operated by speed governor independent of speed regulating valve.

And many other improved features.

DE LAVAL
STEAM TURBINE CO.
TRENTON 2, NEW JERSEY

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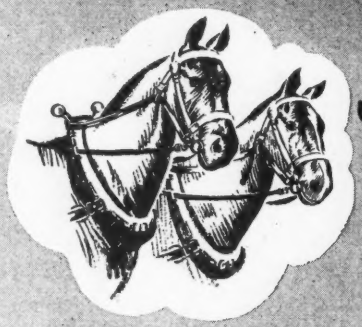
T-14

TURBINES • HELICAL GEARS • WORM GEAR SPEED REDUCERS • CENTRIFUGAL PUMPS • CENTRIFUGAL BLOWERS AND COMPRESSORS • IMO OIL PUMPS

EVERLASTING
Boiler Blow-off Valves...



teamed up for "EVERLASTING" service

4061/6061 Unit; angle blowing valve with wheel-operated sealing valve.

4001/4061 Unit; straightway blowing valve with lever-operated sealing valve.

The unique service qualities of EVERLASTING Blow-off Valves have long been demonstrated in boiler-rooms throughout the country. Now their superior design features have been teamed up in these new EVERLASTING Duplex Blow-off Units. And either unit far exceeds your demands for reliable service in blowing down your boilers.

HERE'S WHAT YOU GET WITH THESE NEW DUPLEX UNITS

Sealing Valve of Either Team Provides (shown on left of units)

- Lever- or wheel-operated types — as you desire
- Unrestricted flow — straight-through
- Rotating sliding disc — self-grinding, self-lapping
- Drop-tight seal — improving with use
- Non-wedge action — no sticking, no jamming

Blowing Valve of Either Team Provides (shown on right of units)

- Straight-way or angle types to select from
- Strength to withstand repeated shock of blow-off force
- Exceptional resistance to erosion, abrasion and rust
- No pockets to permit lodgment of solids
- Positive action, self-cleaning

Not only do these EVERLASTING Duplex Blow-off Units provide an absolutely drop-tight seal — they are so constructed that long and repeated operation will not affect this tightness. Other Duplex Units for varied requirements are shown in our Bulletin.

Either valve of any EVERLASTING Duplex Unit can be supplied separately. But for boiler blow-off applications, any one of the complete units assures *absolute safety — at low maintenance cost.*

Ask your distributor — or write directly to us — for complete information.

EVERLASTING VALVE COMPANY
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Trade-Mark "EVERLASTING"—REG. U. S. PAT. OFF.

EV-328

EVERLASTING VALVES *GIVE "EVERLASTING" SERVICE!*

Good Equipment, Correctly Applied!

THAT IS THE BASIS of effective conditioning of boiler feedwater makeup . . .

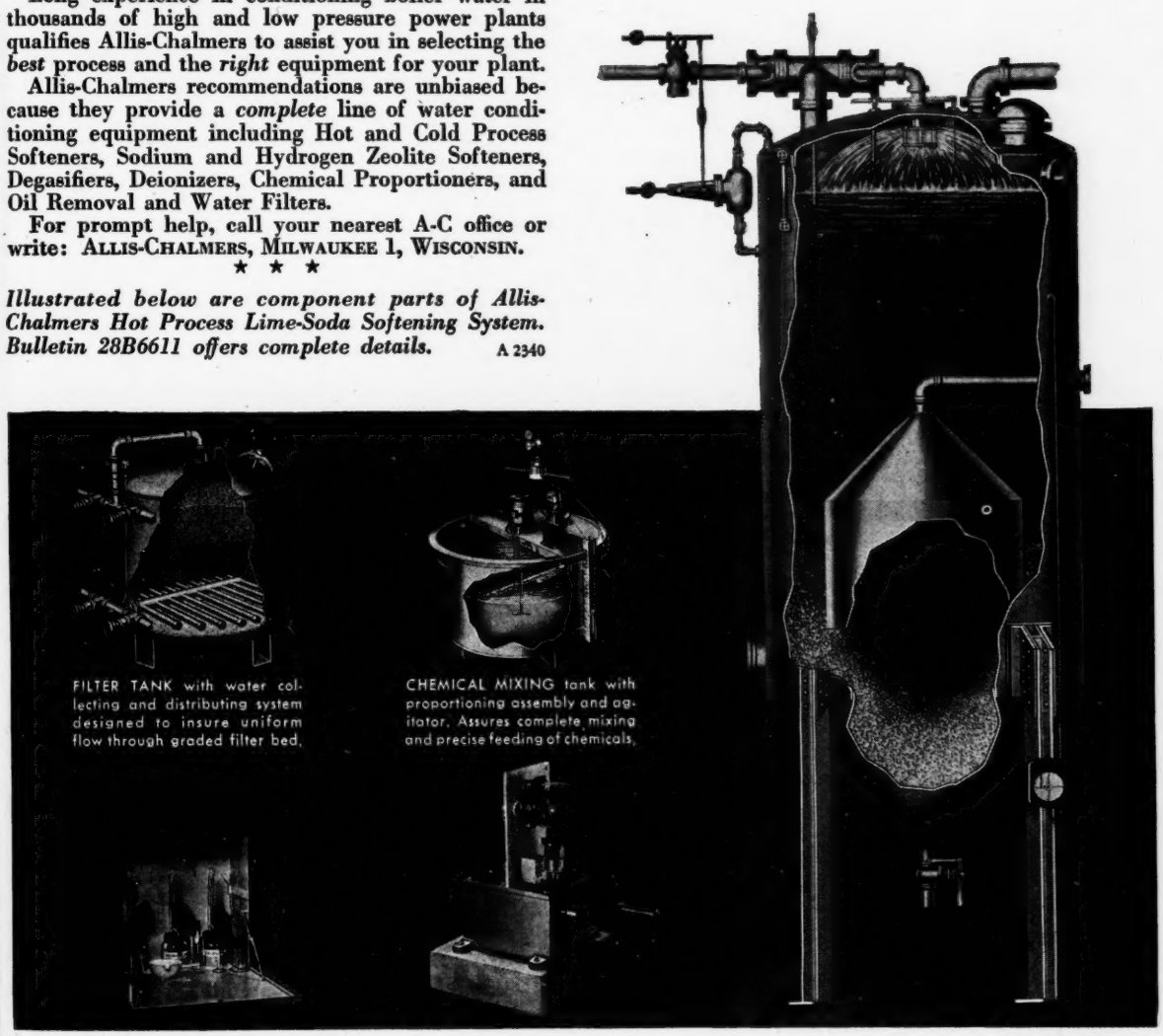
Long experience in conditioning boiler water in thousands of high and low pressure power plants qualifies Allis-Chalmers to assist you in selecting the *best* process and the *right* equipment for your plant.

Allis-Chalmers recommendations are unbiased because they provide a *complete* line of water conditioning equipment including Hot and Cold Process Softeners, Sodium and Hydrogen Zeolite Softeners, Degasifiers, Deionizers, Chemical Proportioners, and Oil Removal and Water Filters.

For prompt help, call your nearest A-C office or write: ALLIS-CHALMERS, MILWAUKEE 1, WISCONSIN.

★ ★ ★

Illustrated below are component parts of Allis-Chalmers Hot Process Lime-Soda Softening System. Bulletin 28B6611 offers complete details. A 2340



FILTER TANK with water collecting and distributing system designed to insure uniform flow through graded filter bed.

CHEMICAL MIXING tank with proportioning assembly and agitator. Assures complete mixing and precise feeding of chemicals.

TEST KIT for treated water analysis and making adjustments in chemical treatment when composition of raw water varies.

ELECTRO-MAGNETIC proportioner with dust-proof cover removed. Vernier adjustment permits micro-control of chemicals fed.

SOFTENER TANK constructed to provide proper flow velocities for effective chemical reaction and sludge sedimentation.

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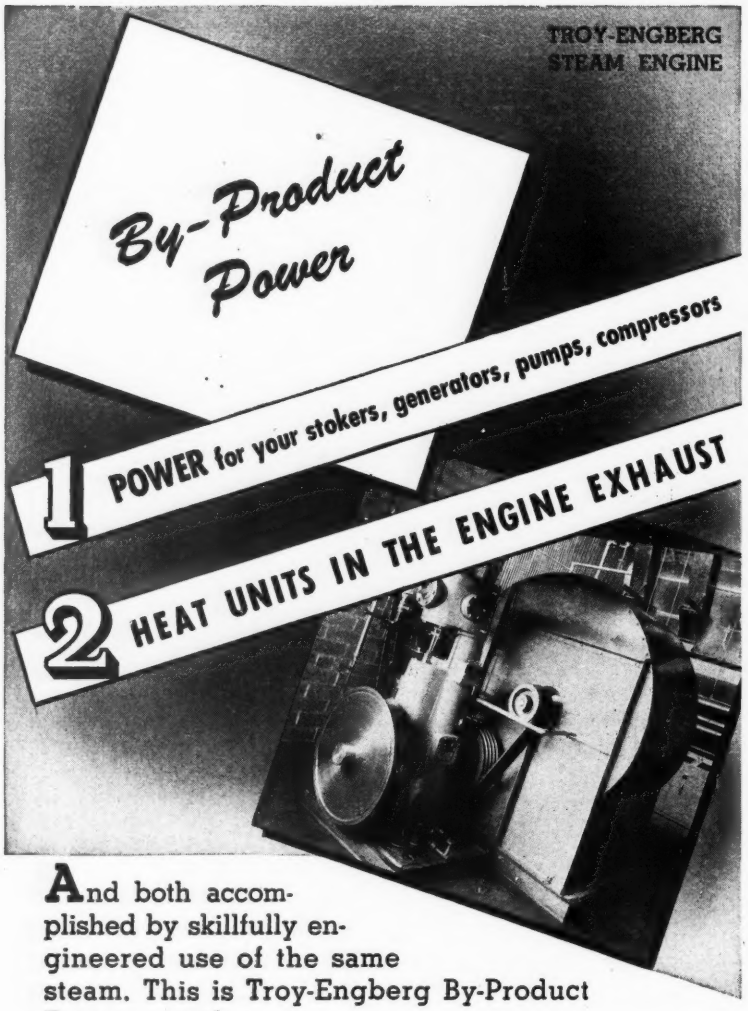
One of the Big 3 in Electric Power Equipment—Biggest of All in Range of Industrial Products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2 HEAT UNITS IN THE ENGINE EXHAUST

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Use the modern Troy-Engberg Steam Engine to drive stokers, blowers, fans, compressors, mixers, generators and pumps—THEN use the exhaust from the engine for your processing or heating, or both.

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New ENGINEERING BOOKS

Chamber's Mineralogical Dictionary; 5½ by 8 inches; 48 pages; cloth; published by Chemical Publishing Co., Inc., Brooklyn, N. Y.; 1948. Price $4.75.

This dictionary lists the chemical composition, crystal form, physical and chemical property, occurrences and uses for over 1400 mineralogical terms. It is beautifully illustrated with 40 colored plates which will help the reader recognize the different minerals. Geologists, mineralogists, metallurgists, jewelers, and chemists, as well as those who use minerals or materials of mineralogical origin will find this volume very useful.

Lincoln's Incentive System, by James F. Lincoln, copyright 1946; first edition, fourth impression; size 6 by 9 in.; 292 pages; stiff cloth binding; published by McGraw-Hill Book Company, Inc., New York, New York; price $2.00.

The general public has often heard about the Lincoln Incentive System but few have taken the time to study into the provisions of this system and its effects on the production of products which has been a result of the application of this system to industry. In this book James Lincoln, the President of the Lincoln Electric Co., and the founder of this particular system of incentives, describes in complete detail his philosophy back of the system and shows in curves and diagrams the results which have been accomplished since its adoption in his factory. He gives in this book his specific tested program for developing latent abilities of the worker for encouraging leadership from within the organization. The book clearly demonstrates how the incentive system can be installed in going concerns and new businesses for the same success enjoyed by the Lincoln Electric Co. The book is divided into 12 chapters the headings of which are as follows: Results of Incentive Management, How to Develop the Worker, Why New Leadership is Necessary, How Should Income be Divided?, Government and Incentive, Collective Bargaining is Civil War, The Advisory Board, How Jobs Are Made, How to Install Piecework, How to Install the Incentive System in a Going Concern, Starting a Business Under the Incentive System, and Economics of Incentive Management.

Standards on Copper and Copper Alloys. 1947 Edition, 454 p., size 6 by 9 in., paper bound. Published by the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa. Price $4.00.

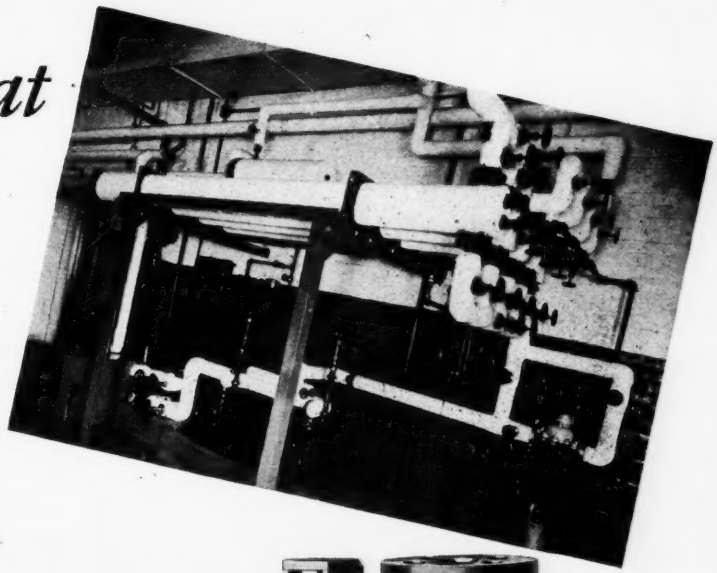
This publication presents in convenient form, 99 specifications for tests for copper and copper alloys. These are grouped in: wire and cable for electrical conductors; non ferrous metals; plate, sheet and strip; wire, rods, bars and shapes; pipe and tubes; and alloys for sand and die castings. A.S.T.M. standards are developed by committees made up of both producers and consumers. They represent up to date thought and practice. In addition to the specifications and tests, they contain a wealth of information and data on standard industrial practice, standard sizes, weights, etc.

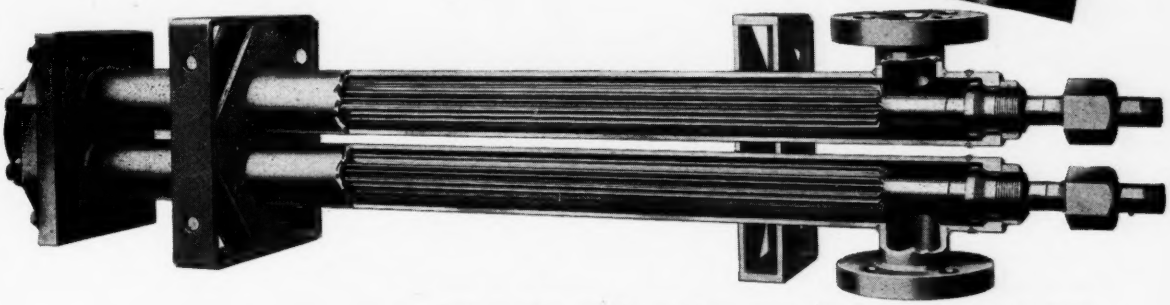
Industrial Apprenticeship, by Paul Bergevin. Size 5 by 8 in.; 210 p.; first edition; six appendices, four illustrated exhibits; bibliography and index; cloth bound. Published by McGraw-Hill Book Co., 330 West 42nd Street, New York, N. Y. Price $2.75.

Dr. Bergevin, director of Industrial and Adult Education of the Anderson (Indiana) Public Schools, has for the last 10 yrs directed an apprenticeship school serving 15 industries in Indiana. The book is an outgrowth of the author's experience since starting his apprenticeship as an electrician in 1924. Apprenticeship which existed as long ago as 4000 B.C. has in the ensuing 6000 years had many ups and downs. Today, the general trend is toward more industries incorporating planned training programs in these activities. Apprenticeship is a highly specialized form of education which Dr. Bergevin is highly qualified to discuss.

Following a brief history of apprenticeship, the author covers the general principles, planning and organization, shops and related instruction, the selection of students and the organization and evaluation of the program. In the appendices and exhibits are included various standards, programs, forms and tests used by companies or the

Isn't this what you want in a **FUEL OIL HEATER?**





SIMPLE — Just a pipe within a pipe—that's the principle of the Twin G-Fin Section. The G-Fin inner pipe, through which the steam passes, has longitudinal fins to provide greater surface for transfer of heat to the oil flowing through the outer pipe.

COMPACT — The longitudinal G-Fins provide at least six times as much heat transfer surface as bare tubes . . . the result: the Twin G-Fin unit has fewer tubes than any other type of heater.

LEAK PROOF — Leakage between steam and oil cannot occur because there are no internal joints.

READILY INSTALLED — The Twin G-Fin Section is easily handled, and can be placed close against a wall, ceiling or floor . . . wherever most convenient. Movable supports further assist convenient installation.

FLEXIBLE CAPACITY — These units are standard and interchangeable. They may be arranged in series or parallel; and at partial loads, sections may be cut in and out to maintain constant oil temperature.

EASY TO CLEAN — The G-Fin heating elements or pipes may be completely removed from the shells for cleaning, without disturbing the oil connections. No special tools are required.

THE GRISCOM-RUSSELL CO., 285 MADISON AVENUE, NEW YORK 17, N. Y. GR-192

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The Universal Heat Exchanger

DARTS close tight-stay tight

because of the GROUND BALL JOINT

A TRUE BALL JOINT ... spherical-ground to form wide, true-bearing surfaces ... makes Darts drop-tight, leak-proof. Darts always give a snug fit without excessive wrenching.

BRONZE-TO-BRONZE SEATS ... are extra-wide to give widest possible bearing surface. And each seat is precision-ground to lock the leaks.

EXTRA-HEAVY SHOULDERS ... shrug off wrench abuse and strains. An important feature that gives Darts a longer life.

PRACTICALLY INDESTRUCTIBLE ... body and nut of air-refined, high-test malleable iron. No wonder Darts last longer ... can be used again and again.

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school system with which the author is associated.

While the book is directly concerned with formal apprenticeship training, the organization, training and methods outlined are equally useful for application to industrial training programs of all types.

Hydraulic Machinery, by Samuel R. Beitler and Eric J. Lindahl; first edition; 218 pages, illustrated; size 6 by 9 in., cloth binding; published by Irwin-Farnham Publishing Co., 3201 S. Michigan Ave., Chicago 16, Ill. Price $3.50.

Mr. Beitler, Professor of Hydraulic Engineering at the Ohio State University, has been intimately connected with research in flow and hydraulic for many years and carried out much of the original investigation in this field. He and his co-author have based this book on notes used in teaching courses in hydraulic machinery to upper-class students in mechanical engineering. The book is well illustrated, especially with phantom views and cross-sections of practical, operating machinery, and should be quite valuable to practicing engineers in studying this equipment.

The term "hydraulic machinery" applies to more than pumps and turbines, for the practicing engineer deals almost constantly with pipe lines, meters, power transmission equipment, and so on, which are truly hydraulic machines. They are all covered in this book. For the practicing engineer, the fundamentals of fluid mechanics are reviewed to help him in solving specific problems in that field.

The book is well designed, well printed on good paper, the discussion is clear and well written and the book should prove useful to all power engineers and plant engineers.

Results of Publicly-Owned Electric Systems, by Burns & McDonnell Engineering Co.; 384 pages; size 7 by 9 in., plastic spiral binding, cardboard covers; published by the Burns & McDonnell Engineering Co., 95th and Troost Ave., Kansas City, Mo. Price $10.00.

This latest edition, the ninth in the series under this title, follows the same general outline and arrangement as preceding editions. It gives the rates, earnings, expenses and other operating records of the publicly-owned and operated electric systems in 590 cities in the United States. These include the results of all the large cities operating electric systems and many small ones down to 2500 in population.

The 590 cities recorded, out of a total of 3460 communities having publicly-owned electric systems, give a fair cross-section of the results. The statistical results cover comparisons of steam, Diesel, hydro and purchased power. These are the only published data pertaining exclusively to publicly-owned utilities. Information is also given in the volume regarding the many Federally-owned power systems.

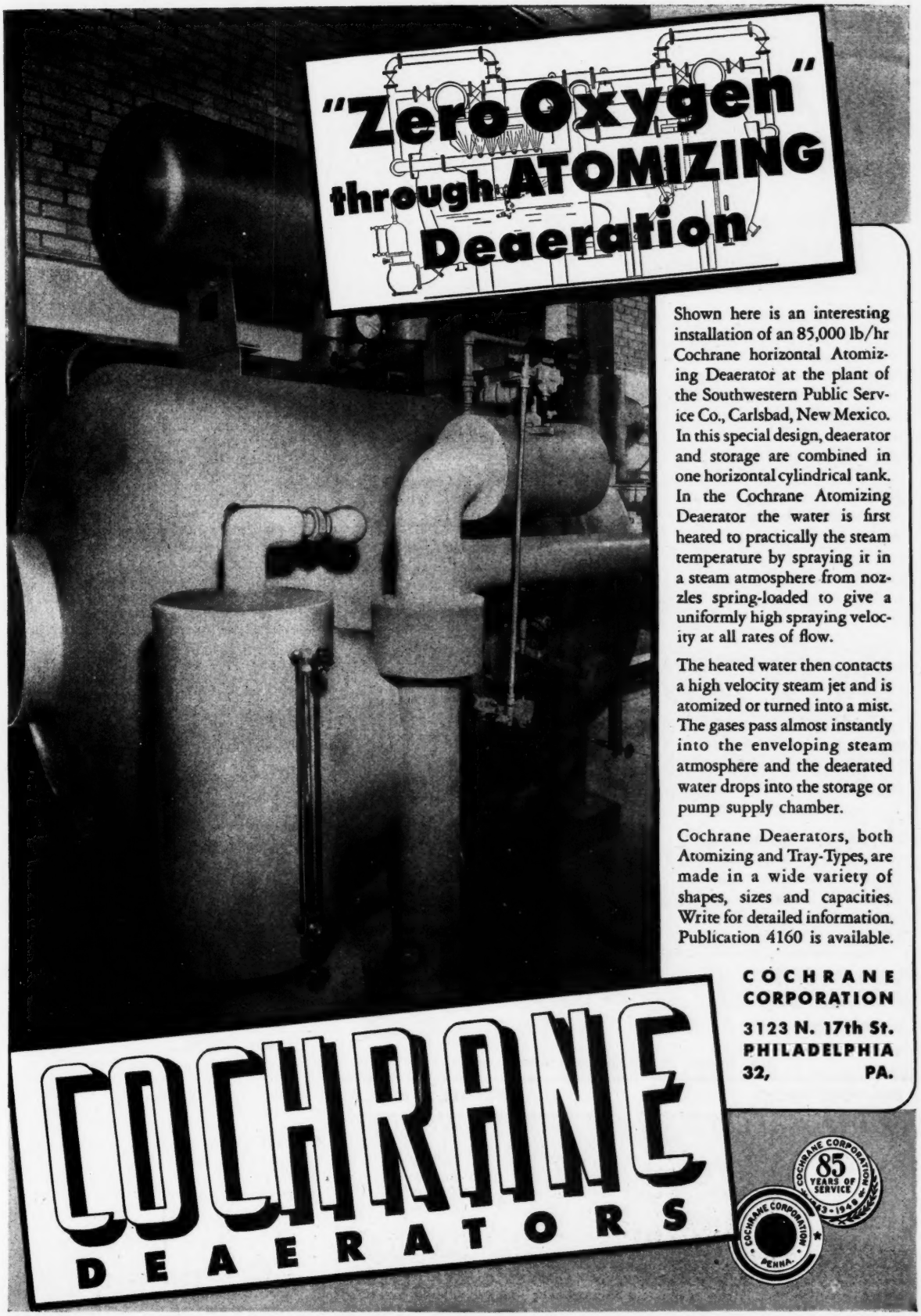
The book is designed especially for the reference of consulting and design engineers, city managers, mayors, superintendents, or anyone interested in the utility business.

WHITING REFINERY

(Continued from page 90)

elevator in the boiler room for access to the upper levels.

The sedimentation tanks are equipped with automatic sludge blowdown valves for continuous withdrawal of sludge precipitated in the bottom cone. To facilitate sludge removal, the bottom cone of the tanks is constructed with an included angle of 70 deg instead of the usual 90 deg. Quick-opening valves for intermittent desludging are also provided. Sludge is withdrawn through pipes leading to an underground tank, in which the vapor is released, before being discharged to the refinery sewer system. A similar arrangement at Stanolind Station No. 2 has given trouble due to the carryover of precipitates with the vapor from the sludge tank. The vapor from the sludge flash tank at Station No. 3 is condensed in a jet condenser installed in the vent pipe. The con-



Shown here is an interesting installation of an 85,000 lb/hr Cochrane horizontal Atomizing Deaerator at the plant of the Southwestern Public Service Co., Carlsbad, New Mexico. In this special design, deaerator and storage are combined in one horizontal cylindrical tank. In the Cochrane Atomizing Deaerator the water is first heated to practically the steam temperature by spraying it in a steam atmosphere from nozzles spring-loaded to give a uniformly high spraying velocity at all rates of flow.

The heated water then contacts a high velocity steam jet and is atomized or turned into a mist. The gases pass almost instantly into the enveloping steam atmosphere and the deaerated water drops into the storage or pump supply chamber.

Cochrane Deaerators, both Atomizing and Tray-Types, are made in a wide variety of shapes, sizes and capacities. Write for detailed information. Publication 4160 is available.

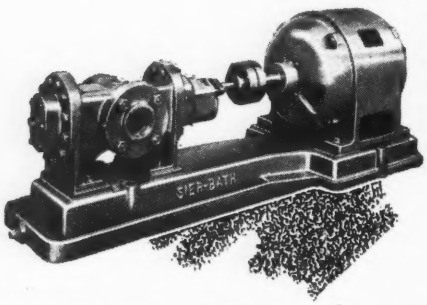
COCHRANE CORPORATION
3123 N. 17th St.
PHILADELPHIA 32, PA.

Can a pump be TOO GOOD?

WE believe that no pump used in industrial processes can be too good. The cost of only one shutdown for pump replacement or repair often exceeds the difference in price between the best pump it is possible to obtain—and the second-best.

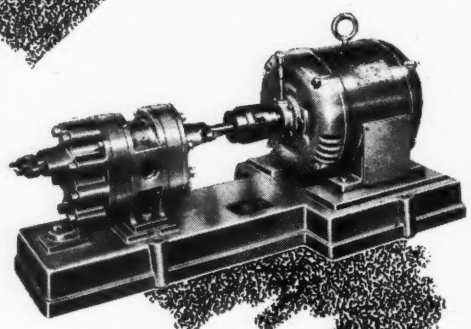
That is why we put *everything* that engineering ingenuity can devise into Sier-Bath Screw Pumps and Gearex Pumps. As a result, Sier-Bath Pumps are noted for their dependability and durability and for requiring the absolute minimum in down-time for maintenance.

Sier-Bath Screw Pumps and Gearex Pumps are made in a modern plant under the best working conditions, by a company that has long been noted for the manufacture of precision gears. In the making of our pumps we adhere to the rigid standards of high quality that have made Sier-Bath Precision Gears famous among manufacturers of quality products. Send for booklet on Sier-Bath Screw Pumps or Sier-Bath Gearex Pumps.



SIER-BATH Screw Pump Advantages: Pulseless flow, anti-friction bearings, vibrationless operation, low maintenance costs, rugged construction. Pumps acetate, asphalt, brines, bunker C fuel oil, cellulosics, greases, molasses, syrups, lube oil, etc.

SIER-BATH Gearex Pump
Advantages: balanced axial thrust, vibrationless operation, roller bushings for precision running under load. Pumps oils, varnishes, solvents, molasses, chemical solutions. Capacities 1-550 g.p.m. Discharge 250 p.s.i. for medium or high viscosities, 50 p.s.i. for water.



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densing medium is the cooling water discharged from the generator air and oil coolers, but water from the refinery cooling water system can also be used. The design of the condenser is similar to that of an ordinary barometric condenser.

FLUORESCENT LAMP BALLAST

(Continued from page 67)

ing the time when current approaches and passes through zero.

However, for ordinary jobs where rapid motions are not viewed, or where rotating machinery having speeds at some multiple or even fraction of 120 cycles per second are not present, the stroboscopic effect is not objectionable or in most cases, even detectable. Where this effect is objectionable, such as for lighting machine tool areas, rotating machines of various types, or where other rapid motions must be observed, a "lag-lead" type of circuit such as Fig. 2b and Fig. 3 is extremely helpful. The reason for this is that the light output variation of one lamp is staggered with respect to the other, so that overall variation of total light is very greatly reduced.

Certification Tests

Good design and careful manufacture to provide a uniformly good product represents a hidden quality which is very hard to discover without many special and exacting tests. This is not the most economical approach for many users. Many prefer to select devices which meet a rigid industry sponsored specification[3] as determined by qualification tests and periodic sampling tests performed by an independent testing body.[4]

Ballast Failure Types

Although ballasts will serve faithfully for long periods if properly designed, built and installed, there are occasional failures which cannot be prevented. Some of the types of failures are shown in Table II.

[3] Specification No. 6—Specifications for Fluorescent Lamp Auxiliaries—Sponsored by Certified Ballast Manufacturers.

[4] Electrical Testing Laboratories—New York City.

AIR COMPRESSOR LUBRICATION

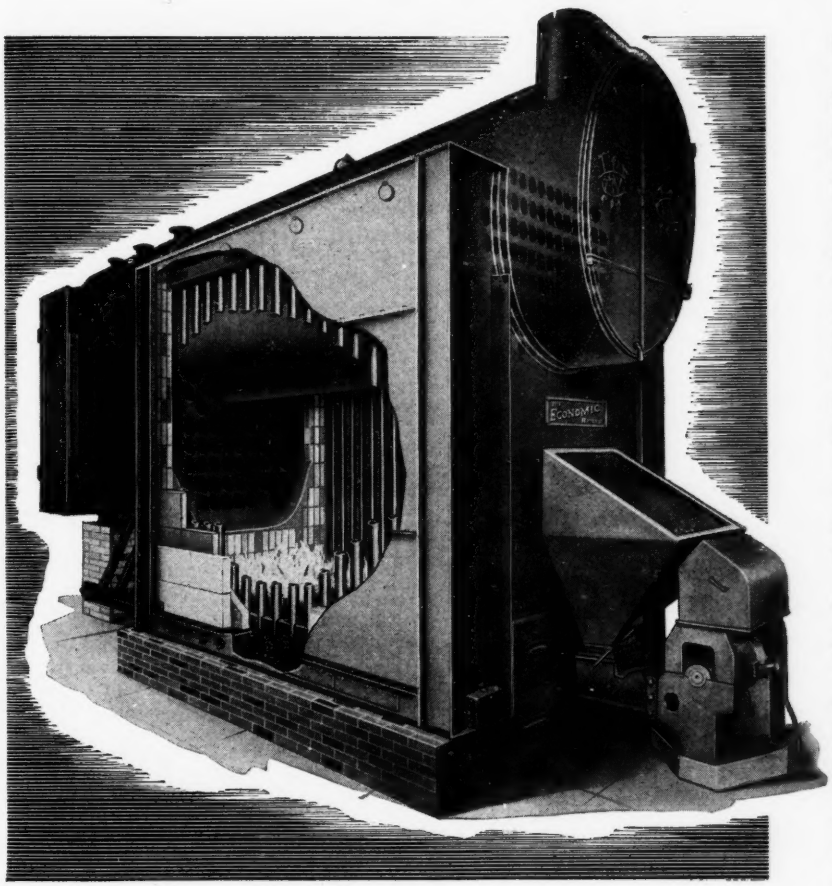
(Continued from page 61)

regular intervals. The proper oil level should always be maintained to insure adequate lubrication, but too high an oil level may cause leakage at the crankcase cover joints. Usually it is not necessary to change crankcase oil more often than once a month, or even less frequently with certain types of compressors operating under normal conditions. However, in the case of a new compressor, the manufacturer's lubrication instructions should be carefully followed during the early operation

ERIE CITY

Provides Water-Cooled-Refractory in a Self-Contained Fire Tube Boiler

SIZES 50 TO 300 H.P.~



Side Walls of Erie City Water Wall Economics are made up of vertical 3" tubes, backed by 2" of refractory tile and 3" of high grade insulation. The whole is enclosed by a steel casing made up in panel sections. Cover plates provide easy access to the handhole plates opposite the circulator tubes in the upper headers and to the key caps in the lower headers. These key caps are arranged so that an angle expander can be used from the outside.

THE Erie City Standard Economic Self-Contained Boiler - Furnace Refractory Unit, used by thousands, has a "big brother"—the *water cooled* Economic. Side wall vertical circulator tubes, exposed to the fire, connected by squared seamless headers, backed by refractory, insulation and steel casing, serve a dual purpose. They provide greater steaming capacities while reducing refractory maintenance to the vanishing point.

The Erie City *Water Wall* Economic Boiler greatly extends the range of economical operation previously possible with ordinary fire tube boilers. It is designed to get the most from any mechanical firing method. These *Water Wall* Economics can be shipped completely built-up in sizes to 300 H. P. Write for booklet that illustrates in detail this modern Self-Contained Fire Tube Boiler with side *Water Walls.*

COMPLETE STEAM POWER PLANT EQUIPMENT

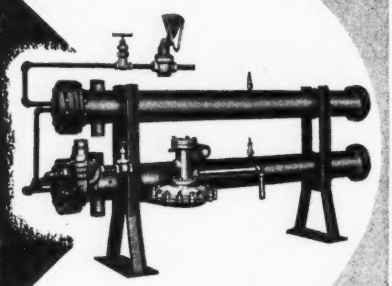
ERIE CITY

Complete Steam Generators • Type C 3-Drum Boilers • Type VL 2-Drum Boilers • The "Economic" Boiler with or without Water Walls • Welded H. R. T. Boilers • Welded Steel Heating Boilers • Coal Pulverizers • Underfeed Stokers • Welded Pressure Vessels for the Process Industries.

ERIE CITY IRON WORKS • ERIE, PA *Since 1840*

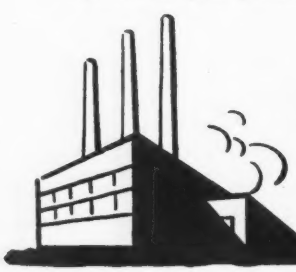
HENSZEY CONTINUOUS BLOWDOWN
will
INSURE
YOUR POWER PLANT

against
PRIMING
FOAMING
SCALE
SLUDGE



The Henszey System automatically keeps boiler water concentrations within safe margins — prevents foaming, priming, carryover and the formation of sludge and scale (with simple chemical treatment). This is accomplished continuously WITHOUT the HEAT LOSS of ordinary intermittent blowdown.

Maintain clean, efficient boilers with Henszey Continuous Blowdown for substantial savings in fuel, equipment and manpower . . . savings you need to hold down costs of production. Plan on a Henszey Continuous Blowdown System for your present — or future — power plant.



Consult your nearest HENSZEY representative or write to

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HENSZEY

CONTINUOUS BLOWDOWN
and BOILER PLANT SPECIALTIES

Boiler Feed Regulators • Distillation Systems • Heat Exchangers
Feed Water Meters • Flow Indicators • Proportioning Valves
also MILK EVAPORATORS and PREHEATERS

period. The oil should be replenished from time to time as required, and occasionally drained and filtered.

The oil for use in the crankcase should have low resistance to shear, good water separating properties, and relatively good oxidation resistance. The constant agitation of the oil and the crankcase air, water, impurities and insolubles with which it comes in contact make these properties very essential.

There are four principal systems, or combinations of them, in general use for the lubrication of air compressor running gear (main and crankpin bearings, crosshead and guides, governors, auxiliary equipment, etc.)

In the splash system, the base of the crankcase serves as an oil reservoir in which the crankpin end of the connecting rod or the counterweight dips. This splashes oil over the moving parts. The crosshead and crosshead guides are fed separately, either from the air cylinder lubricator or by a sight feed drip oiler.

The splash circulating system is similar, except that some of the splashed oil is caught in an upper pocket cast in the housing from which it flows to the crosshead bearings. The main bearings may be ring-oiled or fed by the air cylinder lubricator.

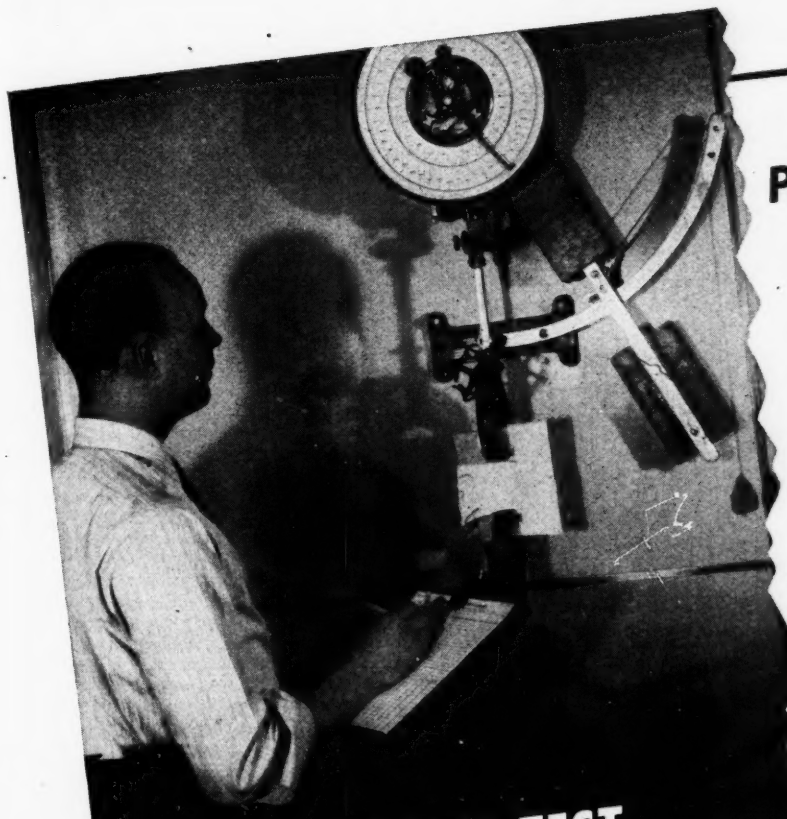
The full pressure system utilizes an oil reservoir which may be either in the crankcase or in an outside sump. A positive displacement pump draws oil from the reservoir and delivers it through piping to the main bearings and through drilled passages in the crankshaft, to the connecting rod bearing and crosshead.

The pressure and splash system is similar to the splash system. However, a pump also draws oil from the reservoir and delivers it either directly to the main and crankpin bearings or to an overhead tank from which it flows by gravity to the main and crankpin bearings.

Different sizes and types of air compressors utilize different lubrication systems or variations of them. Among such lubrication arrangements are governor bearings, gears and other parts that are automati-

TABLE OF CYLINDER LUBRICATION OIL REQUIREMENTS

Cyl. Dia. Inch	Piston Displacement per cyl. cfm	Oil feed Drops per min.
Up to 6	Up to 65	2 dr. in 3 min.
6 to 8	65 to 125	1
8 to 10	125 to 225	4 dr. in 3 min.
10 to 12	225 to 350	1 to 2
12 to 15	350 to 600	2 to 3
15 to 18	600 to 1000	3 to 4
18 to 24	1000 to 1800	4 to 5
24 to 30	1800 to 3000	5 to 6
30 to 36	3000 to 4500	6 to 8
36 to 42	4500 to 6500	8 to 10
42 to 48	6500 to 9000	10 to 12



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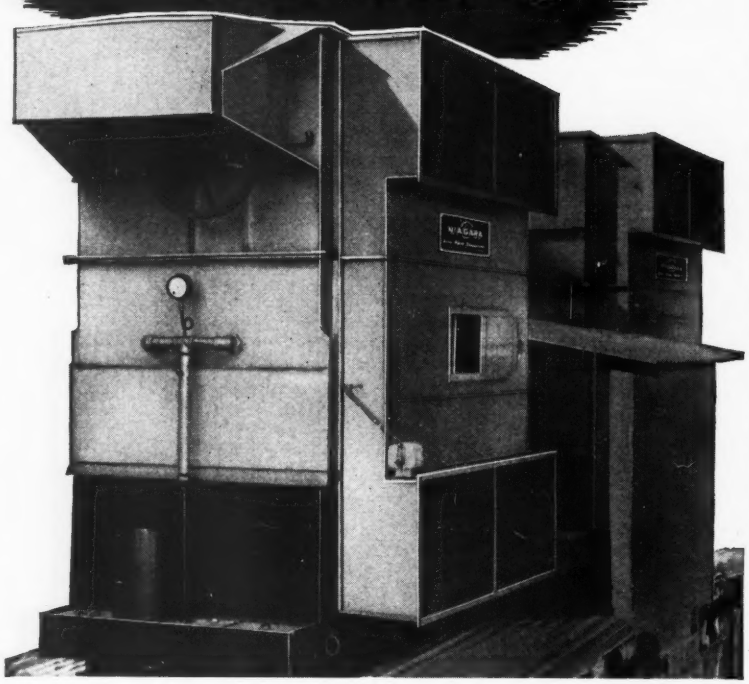

● Better control of quenching temperatures improves the heat-treating process, gives better physical properties to steel, increases production with fewer rejections.

That is the experience with the use of NIAGARA AERO HEAT EXCHANGERS, providing faster and more accurate cooling to specified temperatures for quench baths, either oil or water. Production is increased; unit costs are lowered. Commercial heat treaters have increased profits; heat treating departments have contributed savings.

NIAGARA AERO HEAT EXCHANGERS are built in a range of sizes to fit any installation. Saving of cooling water quickly pays for the equipment.

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cally lubricated; a hand priming pump to prime the lubrication system before starting the compressor; sealed frame construction in which a built-in pump delivers continuously filtered oil through the hollow pump drive shaft and arm to the crankpin and thence to all bearing surfaces through drilled passages, thus eliminating the need for external piping; bearing pressure gauges and temperature indicators; oil-pressure failure automatic shutdown mechanism; oil filters and coolers; and on integral gas and diesel engine driven compressors, power cylinder walls, camshaft bearings and valve tappets lubricated by throw-off oil spray, power pistons cooled and auxiliary parts lubricated by oil pressure, and a separate reservoir "one-shot" hand-force pump to lubricate the engine valve stems and rocker arms occasionally during the running period.

Efficient and satisfactory air compressor operation depends greatly on adequate and dependable lubrication, and this can be assured only through regular care and periodic attention to certain details. Oil filters and coolers should be kept clean; oil piping maintained tight and free from any obstructions; oil screens kept clean; and oil pressures and bearing temperatures carefully watched and corrected if not normal.

Oil, water and impurities should be drained regularly from the receiver tank, coolers and discharge air pipe; air pressure gauges, valves and safety valves checked periodically; air cylinder intake and discharge valves examined regularly; proper oil level maintained; crankcase drained and cleaned regularly in accordance with operating conditions; and the intake filter kept clean and in good condition.

In the matter of lubricating oil selection, it is advisable to rely upon the advice and suggestions of a

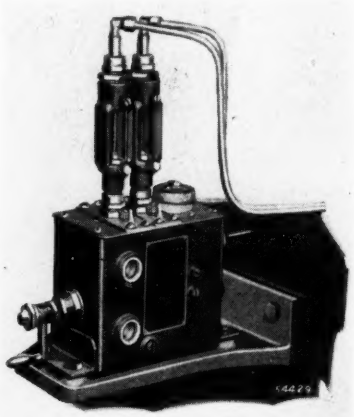
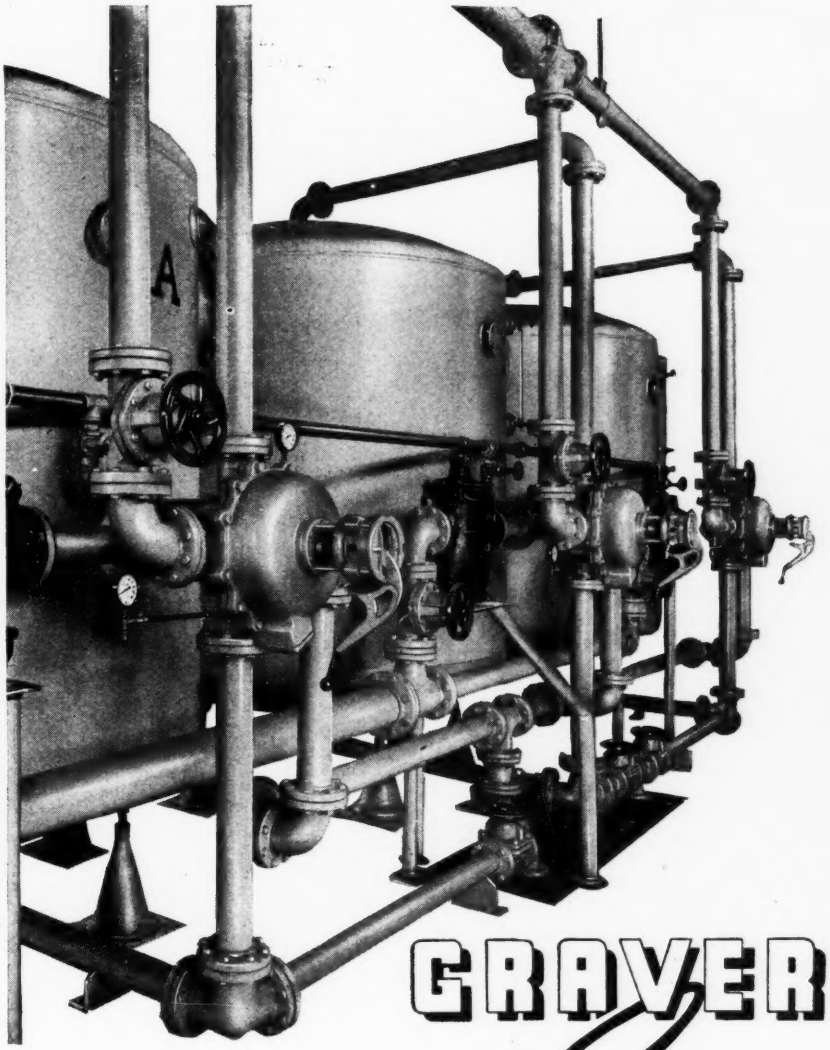


Fig. 4. Two-unit air compressor lubricator. (Photo. Ingersoll-Rand Co.)



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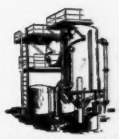

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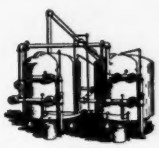

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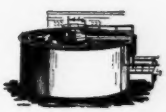
DEMINERALIZERS



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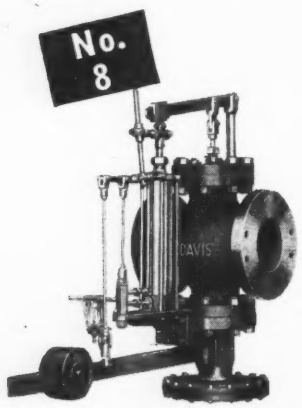

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lubrication engineer. All reputable oil companies employ such experts and will be glad to cooperate in any way possible to insure the efficient and proper lubrication of air compressor equipment.

In matters pertaining to the machinery itself, the manufacturer should be consulted.

The wealth of experience of the equipment makers and the oil companies is readily available to assist operators in obtaining the most satisfactory operation possible from their equipment. And the utilization of this information will insure maximum operating efficiency and long, trouble-free equipment life.

FURNACE HEAT TRANSFER

(Continued from page 71)

In addition to the dry components, flue gases do contain water vapor whose percent by weight in the flue gas varies with the fuel and with excess air. It has been found that each one per cent increase in the water vapor (by weight) content of a flue gas increases the enthalpy of the flue gas very nearly one per cent (due to the high specific heat of water vapor).

Calculation shows that bituminous coals average 5% water vapor in the flue gas. The corresponding value for oil is 7% and for natural gas is 12%. For these fuels, enthalpies in Btu per lb of wet flue gas have also been plotted versus temperature in Fig. 7. For extreme accuracy and for other fuels the per cent water vapor in the flue gas may be calculated and the enthalpy values for the dry flue gas multiplied by a factor equal to (100% plus % water vapor in flue gas) ÷ 100 to obtain the enthalpy of wet flue gas.

Excess-Air Determination

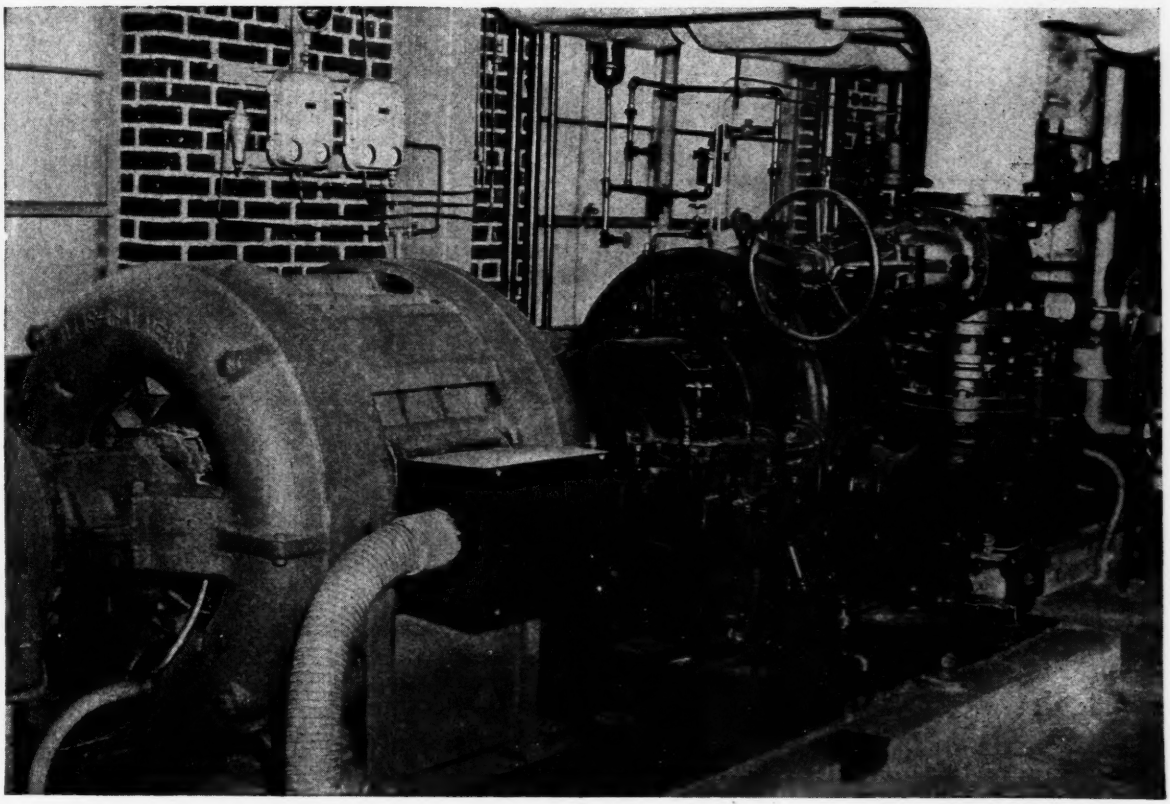
The orsat analysis yields CO_2, O_2 and CO. Either CO_2 or O_2 may be plotted versus excess air. Instead of excess air the equivalent term total air (equal to 100% plus % excess air) is now preferred by many. It is well-known that while on such plots CO_2 versus total air varies widely for different fuels, O_2 versus total air shows little variation hence the plot shown in Fig. 8 may be used to determine total air where CO has been taken into account by using the coordinates indicated.

Overall Furnace Heat Absorption

The procedure outlined in the following is an improvement over procedures outlined in reference (1) in that more modern specific heats are used and flue gas enthalpy curves are based on a pound of flue gas rather than on the pounds of flue gas per pound of fuel.

The overall heat absorption of a furnace may be easily calculated if

The TERRY TURBINE



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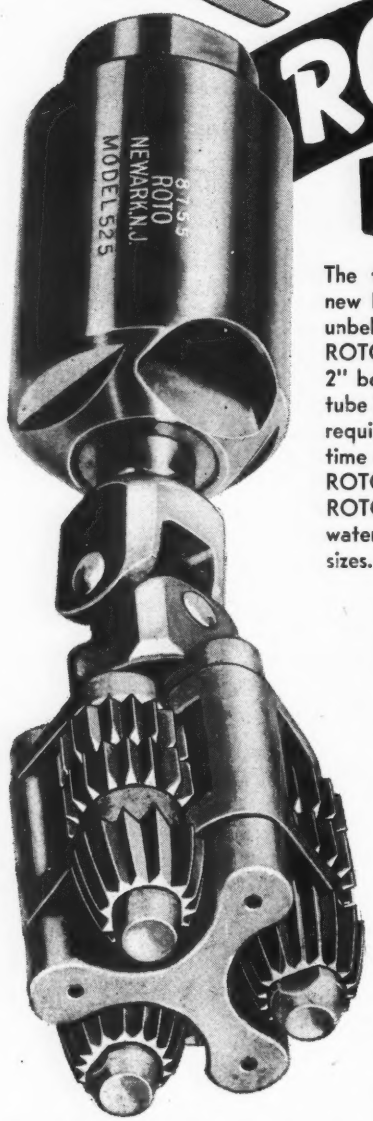
IN THE AIR

ROTOJET

for tube cleaning



Model C-525 ROTOJET Air-Driven Motor with swing frame head and universal joint for 2¼"—3½" I.D. curved tubes.

The tremendous power developed by the new ROTOJET enables it to clean tubes at unbelievable speed. On one recent job, a ROTOJET Model 505 cleaned badly scaled 2" boiler tubes at the rate of 5 minutes per tube in one pass, while ordinary tube cleaners required two passes and 20 minutes. The time and labor saved more than paid for the ROTOJET on this one job alone. New ROTOJET models for operation with air, water or steam are stocked for most tube sizes. Send for new bulletin.

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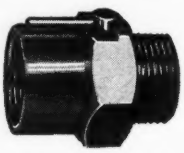
Air-driven
TUBE CLEANERS



Roto Air Valve for curved tube cleaners.

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the correct furnace-outlet temperature has been measured although certain supplementary data must be obtained. Among these additional data the most important is the per cent total air (equal to 100% plus % excess air) obtained by an Orsat at the same location leaving the furnace that the furnace-outlet temperature was obtained. The heat available in the furnace by combustion of the fuel and by preheat of the air must be obtained. This may be done by either determination of fuel weights and air temperatures with proper allowance made for incompleteness of combustion or what is more usual, by measurement of steam flow and calculation of furnace heat available by means of boiler efficiency determined by heat balance methods.

From the analysis of the fuel burned and the percent total air at the furnace outlet as determined by Orsat data the pounds of flue gas leaving the furnace may be determined.

The procedure is best explained by an example.

Data: Pulverized bituminous coal-fired furnace.

Heat available in furnace .....410,000,000 Btu per hr
Furnace-outlet HVT temperature .....2700 F
Furnace-outlet-gas analysis..... $O_2 = 3.5\%$, $CO = 1.0\%$
Furnace water-cooled surface including furnace outlet (projected) .....4100 sq ft
Calculated flue-gas weight for perfect combustion of fuel with no excess air..... .....335,000 lb per hr

Calculations: From Fig. 5 correct (MHVT) gas outlet temperature is equal to 2700 + 100 = 2800 F
From Fig. 8 for $O_2 - CO/2 = 3.0$ total air = 116%
Actual flue gas weight = approximately 1.16 times 335,000 = 388,000 lb per hr or this may be computed more accurately.

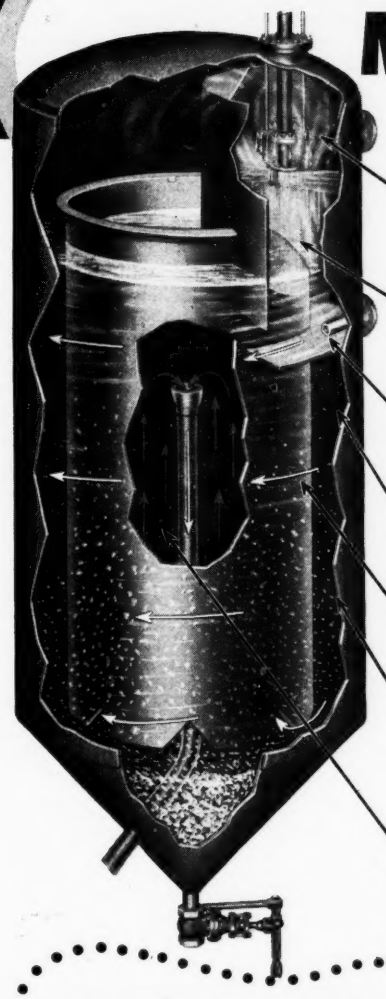
Heat available in furnace $= \frac{410,000,000}{388,000} = 1058$ Btu per lb flue gas.

From Fig. 7 for a temperature of 2800 F and for bituminous coal (5% water vapor) heat in the flue gas leaving the furnace = 796 Btu per lb flue gas.

Since 1058 Btu per lb of flue gas was available and 796 Btu per lb remains in the flue gas leaving the furnace then 1058 — 796 = 262 Btu per lb flue gas were absorbed by heat transfer in the furnace.

For a furnace heat available of $\frac{410,000,000}{4100} = 100,000$ Btu per hr sq ft of furnace water-wall area the furnace heat absorption rate is $100,000 \times \frac{262}{1058} = 24,800$ Btu per hr

MAXIMUM Water Treatment MINIMUM Chemical Cost



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3. A deflector plate, forming the bottom of the mixing compartment, discharges the mixture tangentially into the outer annular compartment, and prevents turbulence of entering water from being transmitted to the reaction and settling space below.
4. Slow, spiral, downward travel for completion of reactions and precipitate formation and agglomeration.
5. A central uptake compartment, having a cross sectional area equal to the annular outer ring, in which the treated water rises *without increase in velocity* to the point of take-off.
6. A "blanketing" effect of the annular compartment surrounding the central take-off compartment eliminates short circuiting from inlet to outlet resulting from convection currents caused by temperature changes and radiation.
7. Adequate facilities for providing hot treated water for filter washing (from the central uptake); and for the return of the dirty wash water to the outer annular compartment for recovery and re-use. No other hot process equipment has *this* exclusive advantage.

As a result of these unique design features, you can be sure the Hot-Flow Softener will provide you with the maximum of treatment benefits and chemical economy.

EXCLUSIVE DESIGN

The Hot-Flow Softener tank is divided into two compartments of equal volume. Chemicals and heated raw water are mixed in the upper annular section above a stilling plate. Chemical reaction is completed as the mixed chemicals and water flow slowly around and downward in the annular section. At the bottom, treated water separates from the precipitate and rises in the central cylindrical uptake to the takeoff, while the sludge settles to the bottom of the tank.

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per sq ft or the total furnace heat absorption is $410{,}000{,}000 \times \frac{262}{1058} = 102{,}000{,}000$ Btu hr.

Predicting Furnace-Outlet Temperature

In an attempt to predict steam-boiler-furnace-outlet temperature (from which mean furnace-heat-absorption rates may be calculated if desired) thousands of measurements have been made. It has not been possible to date to make a simple correlation of data but a number of general conclusions may be formed:

A much better correlation is obtained on a Btu.-per-sq.-ft.-of-water-wall-surface basis than on a Btu.-per-cu.-ft.-of-volume basis.

If furnace-outlet temperature is plotted versus furnace-heat available rate on semi-logarithmic graph paper a straight-line plot usually results as shown by Fig. 9. Curve A is representative of the first slag-tap stage of two-stage pulverized-coal-fired furnaces. The surface considered is the water-wall surface of this first stage only. Curve B is representative of large clean bare-tube dry-ash pulverized-coal-fired furnaces. Strangely enough Curve B also seems to apply approximately to large pulverized-coal furnaces in which the lower part of the furnace is slag-tap with slag-covered walls and the upper part of the furnace is of clean bare tubes.

Varied furnace construction and varied fuels modify these results. If furnaces are operated at continuous high ratings so that ash accumulates on the water-walls results may be 400 F higher as shown by Curve C. This temperature may be lowered again by lancing or by dropping the boiler rating for a short period. The zone between Curves B and C is shown cross-hatched.

Curves D, E and F indicate the approximate values for natural gas, oil and stoker fuels respectively all with clean bare-tube walls. Again, an accumulation, over a period of time, of ash or of soot will increase the temperatures somewhat.

The positions of these curves are not affected by varying excess air.

Table 1. Superheater and Economizer Heat Balance

Method of Measuring Inlet Temp	MHVT	HVT	OPT PYR	TC	RAD PYR
Temp superheater inlet deg F	2010	1960	1836	1770	1750
Temp economizer outlet deg F	516	516	516	516	516
Calc. heat given up by gases passing from inlet to outlet temp. in million Btu/hr	120.4	115.8	105.9	100.6	98.8
Percent heat accounted for	99.8	96.0	87.7	83.3	81.8

Heat Balances

That accurate gas temperature measurements and accurate specific heat data are necessary may be illustrated by a heat balance made on a boiler in which the superheater and economizer were entirely separate from the boiler heating surfaces.

During a test on this boiler it was found that the heat received by the feedwater passing through the economizer was 59,200,000 Btu per hr and the heat received by the steam in the superheater was 61,600,000 Btu per hr making a total of 120,800,000 Btu per hor. Since this heat was entirely absorbed from the flue gases, as they passed from the superheater inlet to the economizer outlet, it was possible to check this value by calculating the heat given up by the gases as shown by Table 1.

It will be observed from Table 1 that only by using the MHVT temperature was it possible to account for all the heat received by the superheater and economizer. At the economizer outlet where the radiation error is small, all of the temperatures were determined from Orsat analyses made at superheater inlet and economizer outlet. To obtain a good check it was necessary to

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Acknowledgement

Much of this work, involving extensive field tests on operating boiler furnaces as well as laboratory checks on instrument accuracy, was conducted by the Babcock and Wilcox Company during the writer's affiliation with them. Grateful acknowledgement is made for permission to use the data resulting from these investigations.

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CHEMICAL FEED SYSTEMS

(Continued from page 63)

installed, in the case of small boiler plants, on the suction side of return condensate pumps or in a by-pass arrangement on the city water line, where city water pressure forces the chemical charge into the boiler upon by-passing the water through the feeder.

Shot feeders are convenient and economical for injecting precipitating chemicals such as phosphates, caustic soda and soda ash to boilers, thus reducing the hazard of feedline deposits caused by premature reaction of these chemicals with the incrusting salts present in the feedwater. If the chemical treatment is added frequently, the treatment will usually average itself among the boilers on line. However, the number of boilers treated in this manner generally should not exceed three, otherwise it will be extremely difficult to maintain consistent chemical balances in all boilers.

Where a large number of boilers are in use, it is relatively common practice to install a feeder for each boiler, the inlet to the feeder being taken from the pressure side of the boiler feed pump, the outlet discharging within the boiler drum through a separate chemical feedline. With the usual difference in pressure between feed pump discharge and boiler drum, this type of installation is quite workable. By this means, the necessary treatment for each boiler can be injected at will. The system, while practical, is rather cumbersome in that an individual charge must be prepared for each boiler.

As is indicated by the foregoing discussion, shot feeders are not suitable for the continuous feed of chemicals such as sodium sulfite (for oxygen removal), caustic soda or soda ash (for pH adjustment) or any of the surface active organic and inorganic chemicals (for prevention of deposits in distribution lines). The shot feed of precipitating chemicals through equipment such as economizers or stage heaters is not recommended, inasmuch as the water flow through units of this nature is sufficiently slow to permit premature reaction of the treatment with the incrusting salts, forming deposits in heat transfer equipment of this nature. This condition is also accelerated by the increase in temperature associated with the operation of units of this type.

Water Jet Eductor:—A second method of shot feed utilizes a water jet eductor, installed as shown in

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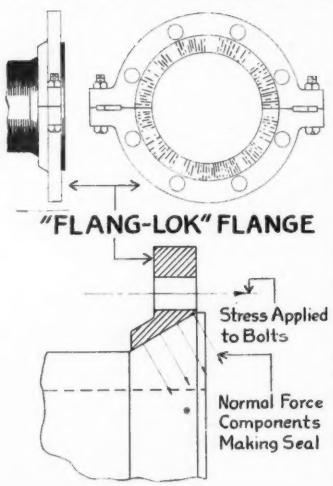

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Fig. 3. The eductor works on the same principle as an injector, using a stream of water under pressure instead of steam. Water from the pressure side of the boiler feed pump passes through a pressure nozzle within the eductor body, producing a high velocity jet. The high velocity jet creates suitable vacuum, drawing in the treating solution and injecting it into the suction side of the boiler feed pump. The eductor of the size ordinarily used has a capacity of approximately 6.5 gpm and any amount of treating solution may be added.

Although the eductor is of advantage in that any amount of treatment may be injected, as compared to the restricted quantity of the "pot" type feeder, the disadvantages of shot feed are inherent in this system as well. In addition, a pressure differential of at least 4 to 1 between the pressure and suction sides of the pump must be available for satisfactory operation of the eductor. Also, it is not possible to introduce the eductor discharge direct to the boiler drum, in the average plant, because of insufficient pressure differential.

Steam injectors are sometimes used in the same manner as eductors. Usually, injectors do not prove suitable for continued use, since their efficiency greatly depends upon proper alignment of internal parts and freedom from deposits. The chemical treatment may attack the metal used in construction of the internal parts and contact of high-temperature steam with the treating solution frequently causes deposits.

Automatic Shot Feed:—A small gear pump, timer controlled, is frequently employed for automatically shot feeding treatment to the suction side of the boiler feed pump. This arrangement is shown in Fig. 4. The timer is regulated to operate the pump for a variable length of time up to a maximum of ten minutes, once each hour. Water characteristics would determine whether more frequent operation would be possible and whether a "shot" of as long as ten minutes duration would be permissible.

Small gear pumps of a suitable type can be obtained at very low cost. Even though the concentrated chemical treatment solution will attack the bronze gears, the cost of the pump is so low that it is quite economical to replace it when necessary.

This automatic shot feed method permits charging of the chemical tank once per day. Due to the frequent additions to the boilers, a larger number of boilers can be treated due to the treatment averaging to all boilers during the course of a day's operation more efficiently than in the case of the previous methods.

Gear pumps of this nature usually

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Constant-Rate Feeders

A constant-rate feeder is one which will continuously add a treating solution at a fixed rate for any given control setting. The rate of feed is adjustable by manual control but is not in proportion to changing water flow. Controlled volume pumps and drip feeders are the most common units falling under this general classification.

Controlled Volume Pump:—The most common example of this type of feed employs a motor-driven chemical feed pump to inject a specific quantity of chemicals into a system at a given time. Figure 5 illustrates a chemical pump of this type and Fig. 6 shows the installation of such a pump.

A chemical feed system of this nature is used most frequently in the continuous feed of sodium sulfite to feedwater heaters or feedlines and for discharge of precipitating chemicals such as phosphates within the boiler drum against boiler pressure. When the rate of flow is relatively constant, a system of this nature can be used to introduce treatment to once-through cooling and water distribution systems. This system is also used quite frequently to insure introduction of the proper amount of chemicals to a circulating cooling water system.

It is necessary to supply one pump or one pumping cylinder for each point of application of treatment. The capacity of the pumps used is generally in the range of 3.0—10.0 gph per cylinder. It is impossible to throttle satisfactorily the discharge from one cylinder so that several discharge points will receive an equal amount of treatment. This is because the discharge rate is too low to permit satisfactory division of flow, even when using various types of specially-designed flow control valves.

Employment of this system of feed readily appoaches proportional feed where the chemicals are injected into a large body of water, such as is contained in a boiler or circulating cooling system. It is common practice to maintain certain chemical residuals in the water being treated. In the average plant, control tests are conducted with sufficient frequency, so as to maintain chemical balances in the system within prescribed limits. While there will be periodic variations, this type of system will maintain chemical balances within limits, on the average. Usually, a suitable factor of safety is incorporated when prescribed limits are established by the water consultant. During the course of operation, therefore, sufficient treatment is present at all times and adjustments are readily made if the control tests so indicate. These adjustments involve changing the length

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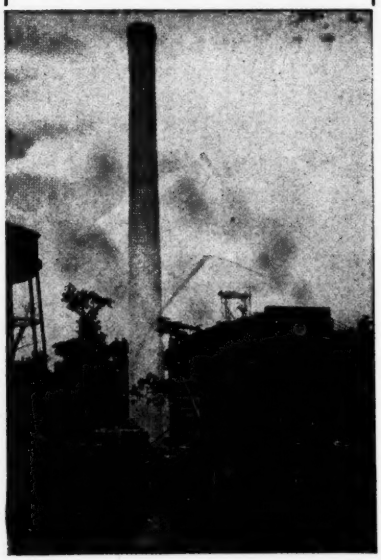

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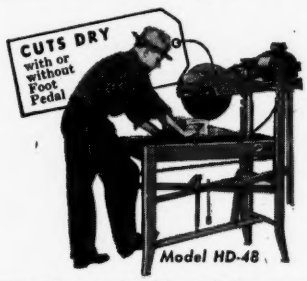

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of stroke on the pump or changing the strength of chemical solution being pumped.

Drip Feeder:—A rather crude type of constant-rate feeder, described as a drip feeder, consists of a suitable tank with bottom take-off and control valve for governing solution discharge. By controlling the flow of treating solution by means of a needle valve, an almost constant volume of solution is added over a given period of time. This is a strictly gravity type feeder and finds application frequently in the addition of acid and other chemicals to circulating cooling systems, air washers in air conditioning systems, and addition of sulfite and like chemicals to some point in a feedwater system permitting gravity flow.

While a feeder of this type is readily fabricated, in actual use it requires constant attention to make certain the discharge line is not plugged with some foreign material.

Proportional Feed Systems

There are a considerable number of systems for achieving feed of chemicals proportional to the flow of water, involving a great number of mechanical and electrical principles in their operation. The more commonly used devices and the principles upon which they are based will be covered in detail in Part II of this article in a subsequent issue.

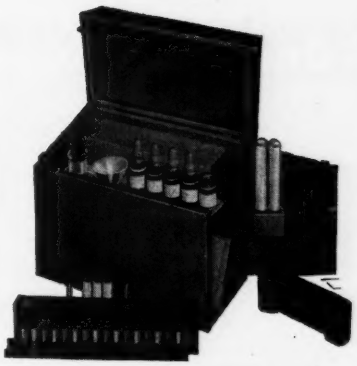
DRY TYPE TRANSFORMER

(Continued from page 94)

tion is used, making the transformers practically fire and explosion proof.

It was desirable that these transformers be installed inside the building close to the load buses to keep the secondary leads from transformer to load bus as short as possible. Oil-insulated transformers or any other oil-filled equipment in this location was ruled out for obvious reasons. Installation of oil-filled transformers outside the building would have increased the cost and resulted in increased voltage regulation. Non-inflammable, liquid-filled transformers might have been used within the building but the handling of liquids of any type in the location chosen for these transformers was considered undesirable. Furthermore, the greater weight of liquid-filled transformers, if used in the location decided upon within the building, would have required expensive additions to the structural steel to assure a safe building loading.

Each of the six auxiliary power buses are located in separate rooms which have non-communicating ventilating facilities. For overall economical station design, these rooms are located above the heater



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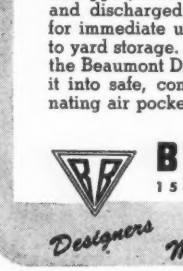

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bay between the boiler house and the turbine room. The dry-type transformers are located in two of these rooms with their associated 4-kv buses and switchgear, thus eliminating long low-voltage leads between the transformers and buses.

Filtered cooling air is fed into the separate auxiliary-power rooms and other switchgear rooms from an outside blower room through individual duct systems. A portion of this cooling air is drawn through the transformer banks by means of an exhaust duct which is connected directly to the top of the transformers. Exhaust air is discharged into the boiler house. The duct divides into a wye at the discharge end where two exhaust fans are located. One fan is always in operation and circulates enough air to cool the transformer for all loads up to 6000 kva. The second fan operates automatically, as required by changes in load or ambient temperature, to circulate the required amount of cooling air for loads in excess of 6000 kva.

Automatic temperature control and alarm are provided by bimetal temperature relays. Two relays are mounted on each core and coil assembly so that the hot air leaving the coils must pass through them. The relays also carry current through their heater elements proportional to the load. Their areas and electrical resistances are proportioned so their temperatures follow closely the temperature of the hottest spot in the transformer winding.

One of these relays controls the fan used for loads in excess of 6000 kva. The second relay protects the transformer from dangerous overloads by initiating an alarm when the transformer temperature becomes excessive. Safe short-time electrical overloads within the thermal capacity of the transformer are thus made possible. If for any reason the overload exhaust fan fails to start, the alarm relay gives ample warning before trouble develops.

Economy, reliability, and safety are increased through use of these dry-type transformers. Because of their 20-percent weight saving over liquid-filled transformers, expensive structural reinforcements were unnecessary and it was possible to locate them close to the electrical load, saving long runs of costly secondary leads. Dual rating with forced-air cooling keeps the transformer size to a minimum, lowering the first cost and reducing the floor area required. Thermal relays insure maximum output from the transformers without endangering their reliability or materially reducing their life. The transformers are practically fire and explosion proof reducing to a minimum the hazard to personnel or equipment located in these rooms.

POWER ENGINEER'S FUTURE IS BRIGHT

(Continued from page 51)

tion of high frequencies is opening up literally hundreds of new electric heating opportunities. A typical application of induction heating in the 9600-cycle frequency range is the simple hardening of crankshaft bearings.

There is also use for frequencies ranging from 110 to 450 kilocycles. In this case, oscillators are used as a source of high frequency energy, these oscillators being similar to broadcasting station type and ranging from 2 to 200 kw; 1200 kw has been used in one installation. There are some applications being discussed at the present time with as much as 3000 kw in one installation. Here is an electronic device that is in reality a power device.

The use of still higher frequencies in the mega-cycle range has developed another field for electricity, known as dielectric heating.

A discussion of all the new uses of electricity would more than occupy my allotted time. There are such other applications as new methods of welding, increased use of electricity on the farm, extensive air conditioning, infra-red heating in industry, and so on.

How are we going to generate these vast amounts of power? There are many sources of power, a few of which are: solar, wind, sea water, tidal power, hydro electric power, fuel burning plants with petroleum, natural gas, and coal, as the fuel, and the newest source, atomic energy. None of these can be ignored in thinking of future sources, as their relative importance may change depending on changing economic conditions. Some of the problems in fuel-burning plants make an interesting example of why the power field should be a real challenge to the new generation of engineers.

In the generation of power using the thermal cycle, there has been a continuing increase in steam temperatures and pressures. The highest temperature plant built to date has been for 1050 F and the highest pressure plant in operation is 2400 psi. The increase in temperature and pressure has introduced an infinite number of metallurgical and other problems. As these problems are solved, there will be a continued increase in the temperature used in plants. The steam generating equipment is the oldest in the power business, yet there are many opportunities for new engineering thinking if more efficient steam plants are to be realized.

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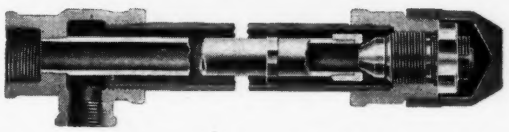

MANY APPLICATIONS

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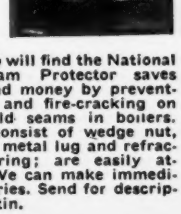

We have been using the National Girth Seam Protector for several years and they certainly do the job. . . . Have reduced our boiler repairs at least 75% since using these protectors, one of the best investments we ever made.
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TYPE 38

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HIGH EFFICIENCY
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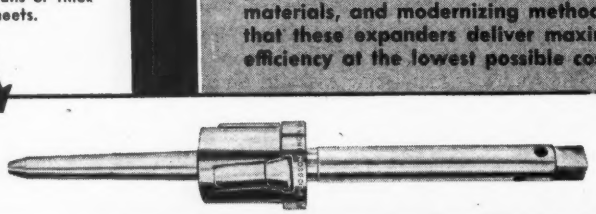

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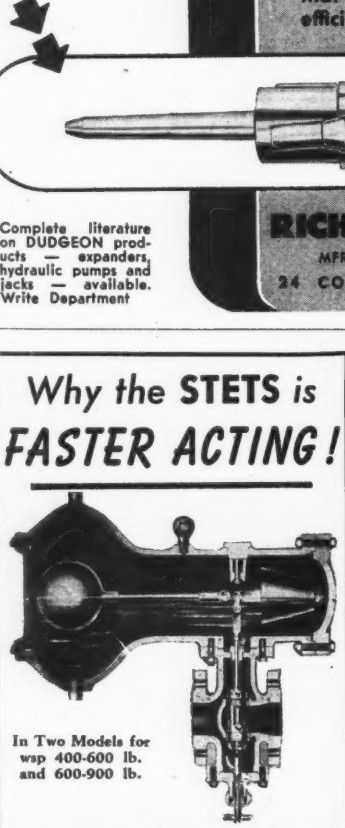

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IMO PUMP DIVISION of the
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turbine is in its infancy and is probably as great a challenge to the engineer of today as any project in the power field.

The War dramatized another form of power, namely, that of nuclear energy. With the United States Government spending approximately $500,000,000 a year on various developments of nuclear energy, this is ultimately bound to have an effect on industrial methods in this country. It is a real challenge to the rising generation of technically trained people.

But generation is not the only part of the power business that should be attractive to engineers. In the field of transmission, the need for higher voltage than is now in use in this country has not been apparent to date. There should not, however, be too much complacency, because the installation of power in the amounts mentioned earlier will necessitate higher voltages to distribute the power, otherwise considerable valuable land will be taken up with transmission systems. Also, no doubt some of the more remote hydroelectric projects will be developed as relative costs and availability of different fuels change.

Hand in hand with the necessity for higher voltages will go the development of higher voltage transformers, circuit breakers, relaying, and all types of equipment that constitute the transmission system.

The greatest challenge today in the electrical industry is in the design of the distribution system. Concentrations of power in residential areas are being experienced that necessitate increased voltages; and our way of life is becoming so closely tied to electricity that reliability is becoming a greater and greater factor. Likewise with the greater use of electrical energy in manufacturing plants, particularly in connection with processes that must be carefully controlled, greater care must be used in the distribution of power not only by the utility but also in the plant itself.

With the greater use of electrical energy in industry, there is going to be a greater need for men who can design and operate industrial distribution systems and processes.

Likewise, the utilities must have men sufficiently versed in the new manufacturing techniques to sell the use of electricity and make the proper layouts for serving the new types of loads. On the other hand, the manufacturers must have men who cannot only sell the equipment to the utility or the user but who are capable of technically analyzing the best performance of their equipment and suggest changes to better cope with the broader use of electricity in industry. Back of these people must be men who are continually improving manufacturing processes and the materials used in the product.

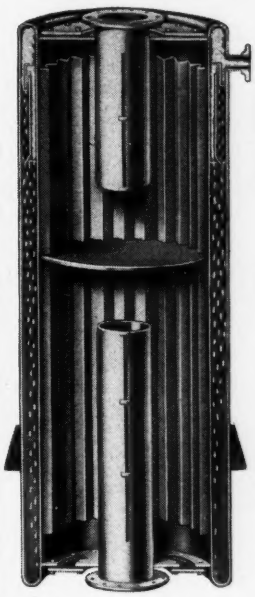
OPERATION of high pressure steam generating units with high percentages of make-up, in some cases as much as 100 per cent of treated water, together with the prevailing necessity for reducing silica in boiler water to a value low enough to prevent deposits in superheaters and turbines, are two problems engaging the interest of many engineers today.

For that reason the dual-circulation boiler installed at the new power plant of Standard Oil Company (Indiana) for the Whiting Refinery, as described in Part II of the article Standard Builds 1250 psi Topping Plant for Whiting Refinery, POWER GENERATION May 1948, page 66, has attracted considerable attention. In this dual-circulation boiler, two separate heat-absorbing sections are employed. Each has its own circulation system, a primary or radiant section being blown down into the secondary or convection section, the concentration in the secondary section being the highest and the total blowdown from the unit being from the secondary section. Full details of how this is done are given in the above article.

Those interested in this whole idea will also be interested in an article entitled. Series Stage Evaporation published in our English contemporary, *Engineering and Boiler House Review*, December 1947, copies of which have only recently become available. This article describes a method developed about 1937 in Russia for utilizing two different circulating systems, or even more than two, in a single boiler. The development, it is stated, has made considerable progress in that country and a number of high-pressure boilers are designed for it. Series stage evaporation, as carried out by the Russians, consists in establishing in the boiler circuits zones of different salt concentration—the blowdown to be effected from the zone of highest concentration. This is exactly the same idea as that used in the Whiting unit. The great difference, however, is that an actual physical separation of the two circuits is made in the boiler drums themselves by the partitions in the drums. The article explains, with many diagrams, just how this is done and how the concentration in the separate systems may be calculated. One other point should be made. As indicated in the Whiting Refinery article, Part II, the use of the dual circulation boiler under these conditions was first explained in 1946 by W. F. Ryan, engineering manager of Stone & Webster Engineering Corp. in an article published in *Oil & Gas Journal*. However, it is not generally known that Mr. Ryan invented and patented this dual-circulation boiler many years ago. The Whiting refinery power plant is the first to use it.

★ ★ ★

ENDLESS-BELT TYPE DICTATING machine is the latest answer to the famous question "What won't they think of next?" Recently announced by Armour Research Foundation, this is a magnetic device in which a wide endless belt, made of paper and coated with a thin layer of magnetizable material, has an invisible magnetic track imposed upon it in a helical path around the belt. To produce such a track, the belt is run past a magnetic head. A belt that folds to a standard 8½ by 11-in. size will take approximately 45 min. of dictation, it is stated. Business-envelope-size belts have a capacity of about 15 min. and correspondence envelope size belts record up to 10 min. An erase feature makes it unnecessary to keep a written record of errors, for the errors can be wiped out at any time and the corrections recorded in their stead. Folding does not harm the magnetic record. The belt may, of course, be filed; pencil or ink notes may be written on it.



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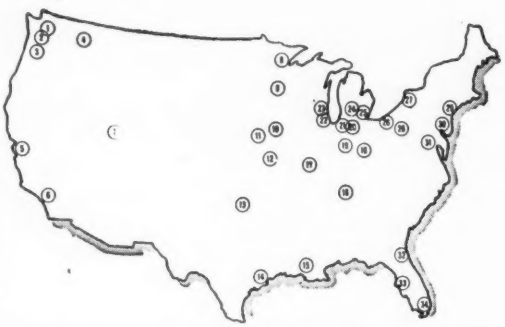

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POWER PLANT *Construction News*

Calif., Fontana—Kaiser Co., Iron & Steel Division, Fontana, plans additional electric power plant facilities in connection with expansion program at mill, including construction of new mill units for production of steel pipe, steel tubing and thin steel sheets, respectively. Entire program will cost about $15,500,000, and will be placed under way soon. Arrangements have been made with RFC for financing in amount noted. General offices are in Latham Square Bldg., Oakland, Calif.

Calif., Riverside—State Board of Public Works, Sacramento, Calif., has plans under way for expansion in boiler plant at State College, Riverside, used for central-heating service, with installation of equipment for increased capacity. No estimate of cost announced. Anson Boyd, State Capitol, Sacramento, is state architect.

D. C., Washington—Navy Dept., Washington, has preliminary plans under way for new pumping station at Waiawa Gulch, Pearl Harbor naval base, Hawaii, estimated to cost about $3,575,000. Project has been approved by Congress in bill known as S. 1675, and funds will be appropriated in near future.

Ga., Macon—Glidden Co., Union Commerce Bldg., Cleveland, Ohio, Durkee Famous Food Division, plans boiler house in connection with new mutil-unit plant for processing and production of oleomargarine, on site near Macon, recently acquired. Entire project reported to cost over $1,500,000. Work scheduled to begin soon.

Iowa, Creston—Southwestern Federated Power Cooperative, Inc., has plans under way for new steam-electric generating station on site near Creston, with installation to include a 15,000 kw turbine generator, high-pressure boiler and accessories. Project will include power substations, transmission lines and distribution systems, with total cost estimated at $4,125,000. Financing has been arranged through Federal aid in that amount.

Iowa, Des Moines—Armstrong Furnace Co., 851 West Third Ave., Columbus, Ohio, domestic heaters and furnaces, plans boiler house at new plant at Des Moines, where tract of land has been acquired. Main works will comprise a one-story building, about 425x450 ft. Entire project reported to cost in excess of $500,000. Milton E. Miller, 582 Oak St., Columbus, is architect.

La., New Orleans—Sewage & Water Board, 522 Carondelet St., plans new water-pumping station at Jumonville and Alvar Sts., to replace an existing temporary station. Cost estimated about $200,000, with motor-driven pumping units and auxiliary equipment.

Md., Baltimore—Consolidated Gas, Electric Light & Power Co., Lexington Bldg., has plans for new power substation at 100-120 North Warwick Ave., to be known as Calverton Substation, and will begin work soon. No estimate of cost announced.

Md., Hagerstown—Potomac Edison Co., Hagerstown, has authorized an expansion and improvement program to be carried out over a period of months, with total expenditure approximating $15,000,000. Project will include new steam-electric generating plant at Riverton, Va., on which work is now under way, to represent an expenditure of about $6,500,000 of total amount noted, including turbine-generator, high-pressure boilers, and auxiliary equipment. New transmission line will be constructed from Riverton to Cumberland, Md., estimated to cost $1,300,000. Other work will include power substations, transmission and distributing lines, and other operating facilities.

Md., Ilchester—Bartgis Brothers Co., paper boxes and containers, has plans under way for new boiler house at local plant. Cost reported about $250,000, with boilers and auxiliary equipment. Westcott & Mapes, 109 Church St., New Haven, Conn., are consulting engineers. Company is a subsidiary of New Haven Pulp & Board Co., 259 East St., New Haven.

Mass., Everett—Monsanto Chemical Co., Chemical Lane, has plans for new power plant at local chemical works. No estimate of cost announced. Proposed to begin work soon. Main offices of company are at 1700 South Second St., St. Louis, Mo.

Miss., Meridian—Mississippi Power Co., Gulfport, Miss.,

has preliminary plans under way for new steam-electric generating station in vicinity of Meridian, estimated to cost about $4,000,000 with turbine-generator, high-pressure boilers and auxiliary equipment. Extensions will be made in transmission lines in that area.

Mont, Helena—Bureau of Reclamation, Denver Federal Center, Denver, Colo., plans call for bids in near future for hydroelectric power station and power dam at Canyon Ferry, vicinity of Helena, forming part of Missouri Basin project.

Neb., Schuyler—Dept. of Public Utilities, has approved plans for addition to municipal steam-electric generating station, for increased capacity in steam division. Installation will include new boiler and auxiliary equipment.

N. J., Dover—New Jersey Power and Light Co., has arranged an expansion and improvement program for next 36 months, to represent a total expenditure of $17,450,000. Of this amount approximately $9,850,000, will be used for increase in power plant facilities. Work is now in progress on an addition to Gilbert steam-electric generation station, Milford, N. J., to include installation of new turbine-generator with rating of 60,000 kw, high pressure boilers and accessory equipment. It is understood that project will be completed early in 1949.

Ohio, Toronto—Ohio Edison Co., Akron, Ohio, will make extensions in steam-electric generating station at Toronto, to include two new 60,000-kw turbine-generator units, high-pressure boilers and auxiliary equipment. Proposed to have one generator ready for operation in fall of 1949, and second unit in spring of 1950. Project is estimated to cost about $12,500,000.

Ohio, Warren—Mullins Mfg. Corp., Salem, Ohio, fabricated metal products, enamel wares, etc., plans installation of new steam-heating system at branch plant at Warren. Also will install new water tower, with capacity of about 125,000 gal. Program reported to cost close to $160,000.

Ore., North Bend—Menasha-Coos Head Plywood Corp., care of Coos Head Timber Co., Empire, near Coos Bay, Ore., recently organized by officials of latter company, plans power house in connection with new plywood mill on waterfront at North Bend, where large tract of land has been acquired. Entire project is reported to cost approximately $2,000,000. Proposed to begin work at early date. Charles Duecy is secretary of new company.

Ore., Rainier—Pacific Power & Light Co., Portland Ore., plans new power sub-station at Rainier, estimated to cost close to $100,000, with transformers, swithgear and accessory equipment. Proposed to begin work at early date.

Pa., Nanticoke—General Cigar Co., Inc., West Church St., plans installation of boiler plant for central heating-service in new four-story factory addition. Entire project reported to cost close to $150,000. Work will proceed soon. Lacy, Atherton, Wilson & Davis, Hotel Sterling, Wilkes Barre, Pa., are architects.

Pa., Philadelphia—Philadelphia Electric Co., has plans for expansion and alterations in Richmond generating station, including construction of new addition and installation of equipment. Award is being made for structural steel framing and work will begin soon. No estimate of cost announced.

Pa., Reading—Metropolitan Edison Co., will increase capacity of power plants during next 48 months to provide approximately 150,000 kw. additional rating. Work will be carried out in conjunction with an expansion and improvement program in that period, including power substations, transmission lines, and other operating facilities.

S. D., Arlington—Light Dept. has plans under way for new municipal power plant. Proposed to use Diesel engine-generating units and accessories. Estimates of cost are being made. G. M. Orr Engineering Co., 1004 Marquette Ave., Minneapolis, Minn., is consulting engineer.

Texas, Dallas—Dallas Power & Light Co., 1506 Commerce St., plans new cooling tower at local generating station. It is understood that work will be carried out by company forces. Cost reported about $170,000.

Texas, Houston—Southern Acid & Sulphur Co., 7621 Wallisville Rd., acids, heavy chemicals, etc., plans boiler house in connection with new plant on local site, comprising several multi-story units. Entire project reported to cost close to $5,000,000. Work will be placed under way soon. Main offices are in Rialto Bldg., St. Louis, Mo.

Texas, Rio Grande City—Sun Oil Co., 1608 Walnut St., Philadelphia, Pa., plans boiler house at proposed new natural gasoline plant in gas field area, near Rio Grande City. Also will construct large compressor station, pressure pipe line system, pumping station and other facilities. Entire project reported to cost about $1,000,000. Work is scheduled to begin at early date.

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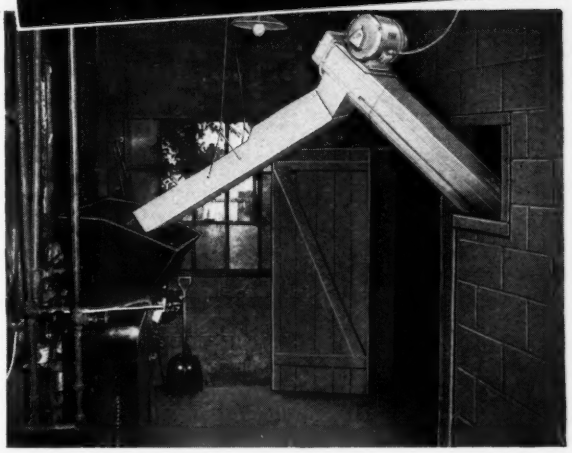
Bin-to-Stoker
Direct Feed Screw Conveyor



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Office located in Eastern Iowa, must be able to travel, bulk of work in middle west, car not essential, salary commensurate with ability.

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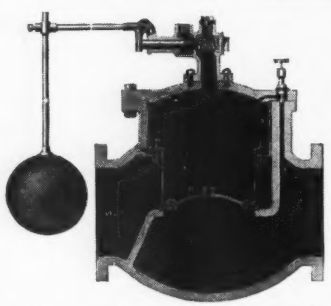

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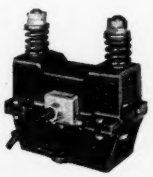

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Eliminate pounding, poking and sledging

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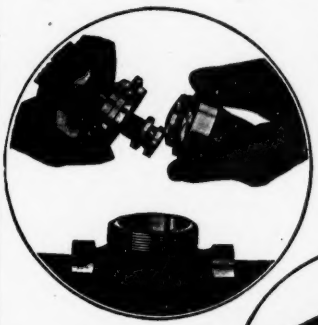
for trouble-free valve jobs



In renewing the disc, note how easily and quickly the Vulcodisc Jiffy Disc Holder slips off the stem head. Only the disc lock nut to remove and the old disc is off and replaced in a jiffy.

Dense without being brittle—tough, yet resilient. Vulcodisc will not swell, warp or soften—in fact, its absorption is less than 1 per cent. . . . That is why an old Vulcodisc comes out of the disc holder as easily as a new one goes in. No need for hammer and chisel to cut the disc out in pieces—distorting and disfiguring the holder.

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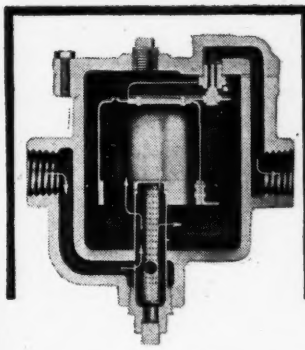
Cincinnati, Ohio



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Inverted Bucket Steam
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Standard sizes ½ to 2 in., 10 to 150 lbs. and 10 to 250 lbs. Forged steel types for pressures to 900 lbs. and for superheat. Catalog 350.

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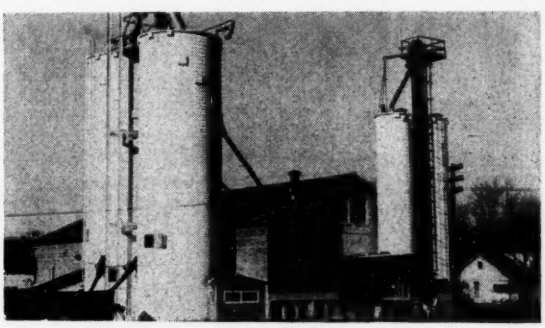
SAVES STEAM SARCO CANADA, LTD., TORONTO 5, ONTARIO



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Sand is elevated into the larger silos and cement into the smaller ones. From there the materials flow by gravity into our factory where each Super-Concrete Stave is formed under 140 tons hydraulic pressure. This tremendous squeeze gives our staves the toughest and densest texture possible in a concrete fabrication.

N. & F. staves are so designed that each one interlocks with six contiguous ones. Then around the zigzag joints rings of heavy galvanized rods are drawn, with as many more between as needed to withstand the calculated internal pressure.

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THE NEFF & FRY CO., CAMDEN, OHIO

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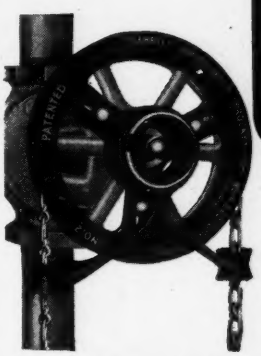
—Adjustable—
SPROCKET RIM
with Chain Guide

Makes ALL Valves *INSTANTLY* Accessible!



Ten standard sizes take care of all types and makes of valves; fit valve wheels from 2 to 30 inches in diameter.

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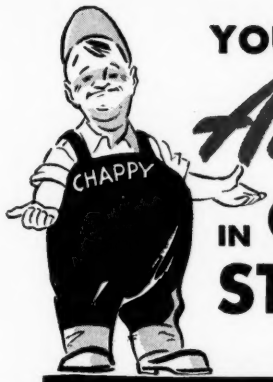

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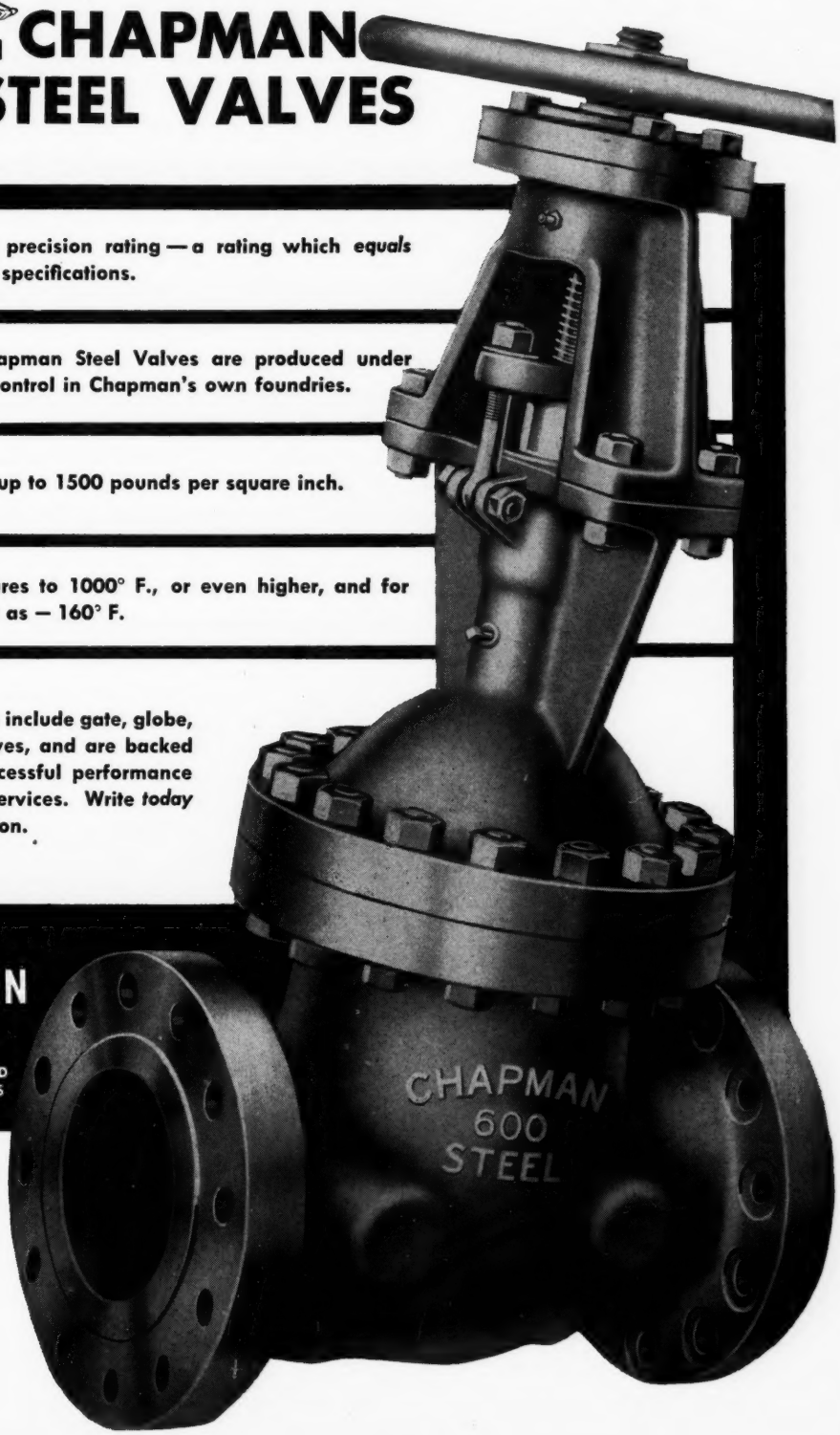

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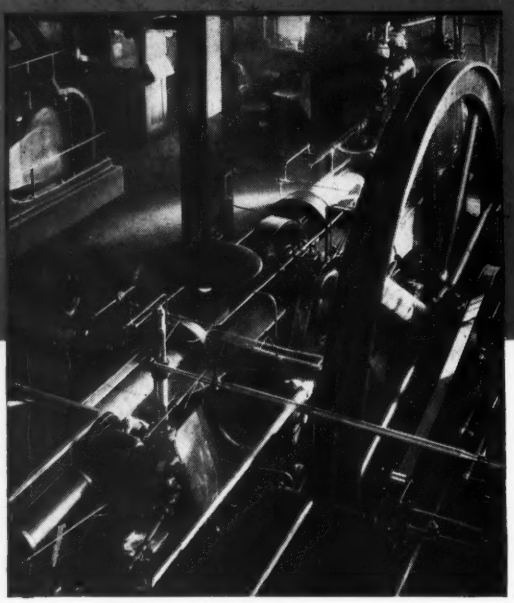

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